URBEMIS7G Computer Program User's Guide

Version 3.1

Emissions Estimation for
Land Use Development Projects

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We also wish to acknowledge Patrick C. Randall who, as an air resources engineer for the California Air Resources Board, designed and developed the original version of *Urbemis* which was released in 1982. Without his creativity and dedication, *Urbemis7G* would probably not exist today.

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I. INTRODUCTION

URBEMIS7G is designed to estimate air emissions from land use development projects. Previous versions of URBEMIS (URBEMIS versions 1 through 5) were designed to estimate only motor vehicle emissions from trips generated by land use development. URBEMIS7G has been enhanced so that the user can estimate construction and area-source emissions. In addition, URBEMIS has been modified to allow the user to estimate motor vehicle trip emissions using EMFAC7G, the California Air Resources Board's most recent motor vehicle emission factor model (hence the name URBEMIS7G). URBEMIS7G also allows the user to select mitigation measures for construction emissions, area sources, and motor vehicle trips.

II. GETTING STARTED

II.1 Memory Requirements

URBEMIS7G is written in Microsoft Visual Basic for DOS. DOS programs were initially limited to 640 kilobytes (kB) of memory, although the 640-kB limit was overcome with the advent of expanded and extended memory. The current version of URBEMIS7G requires 500 kB of DOS base memory to run safely. You can determine the amount of DOS memory available on your machine by typing *mem* (or *mem /c* [enter]) at the C:\ prompt. If you are operating from within Windows 3.1 or Windows 95, you can open a DOS window and type *mem /c* [enter] at the C:\ prompt. If your machine does not have enough free DOS memory, you will have to unload memory-resident programs until you have freed up at least 500 kB of memory.

If you are running Windows 3.11 or Windows 95, you may be able to run URBEMIS7G from within a DOS window. You should check the available DOS memory from within the DOS window, however, before attempting to run URBEMIS7G from a window. If you do not have enough free DOS memory when you are within a DOS window, then you may have to exit Windows and shut down memory-resident programs, either by removing them from memory manually or by modifying your AUTOEXEC.bat file and rebooting your machine.

II.2 Disk Limits

URBEMIS7G does not require substantial amounts of hard disk space. All of the URBEMIS7G files combined (executable files plus EMFAC7G files) take less than 5 megabytes of hard disk space. In addition, you should have at least one megabyte of additional hard disk space to store project files and to allow the program space to write temporary files. All temporary files are deleted by URBEMIS7G at the conclusion of the program.

II.3 Installation

URBEMIS7G can be installed in one of two ways onto a drive that has sufficient memory (see II.1 above). The first method involves downloading URBEMIS7G from the California Air Resources Board's (ARB) Internet web site, and then installing it onto a computer. The second method involves installing URBEMIS7G from program diskettes that can be obtained from local air districts in California. These two methods are described in Section II.3.1 below. An additional method (Section II.3.2) involves installing URBEMIS7G manually using a series of DOS commands without using the installation routine. Section II.4 (on page 6) provides important information on how to start the program once it has been installed.

II.3.1 Normal Installation

a. Downloading and Installing from the ARB's Internet web site

a. 1 *Downloading Urbemis7G from the Internet:*
To download URBEMIS7G from the Internet, go to www.arb.ca.gov/urbemis7/urbemis7.htm and click on the *Urbemis7G* download file. You will then be asked to designate a location for this file on your computer (note: the download file is named 'URBNSTAL.EXE'). **Save this file to your computer's main drive (typically, the "C" drive) into a folder or directory, such as "temp" or "download".** (However, if you plan to install URBEMIS7G using MS-DOS, place it onto the C root, and not into a directory.) Then, after exiting from the Internet, follow the instructions below to install *Urbemis7G* onto your computer.

a. 2 *Installing Urbemis7G:*
You may use *Windows95, Windows 3.1,* or MS-DOS to decompress the URBEMIS7G files and install them onto your computer after downloading them from the Internet. These methods are each described below:

a.2.i Installing Using *Windows95*:
Use Windows Explorer or 'My Computer' to locate the drive and folder into which you downloaded the program from the Internet. Double-click on the URBNSTAL.EXE file, which automatically extracts four additional files and adds them to the same folder. (note: to see these new files, run the "refresh" command under the "view" menu.)

Then you may follow the instructions below to install URBEMIS7G onto your computer:

a) Locate a file entitled SETUPEZ and double-click on it. This starts an installation program which automatically decompresses the URBEMIS7G program files, creates a new folder on the "C" drive entitled "URB7G", and then installs the program into that new folder. (Section II.4 on page 6 provides information on how to start the program once it has been installed.)

b) *If you wish to install URBEMIS7G into a different folder or directory than the default location (for example "Urbemis7" on your C drive):* Using the Windows "Start" button, select "Run". Then, at the prompt, enter the drive and directory into which you previously downloaded the 'URBNSTAL' file from the internet. Then type SETUPEZ followed by the location where you would like URBEMIS7G to be installed onto your computer. For example, if you downloaded the program from the Internet onto your “C” drive into a folder named “temp” and you want to install it onto your “C” drive in a file you wish to name ‘Urbemis7’, then type the following after selecting “Run” from Start:

C:\temp\SETUPEZ C:\Urbemis7

(Note: when specifying a new folder or directory for URBEMIS7G, the name must contain 8 or fewer characters.) Section II.4 on page 6 below provides information on how to start the program once it has been installed.

a.2.i Installing from the Internet Using *Windows3.1*:

1) Open “File Manager” and locate the directory into which you downloaded URBNSTAL.EXE from the Internet.
2) Double-click on URBNSTAL.EXE, which automatically extracts four additional files and adds them to that directory. (Note: to see the new files, you need to refresh the directory listing. To do this, temporarily select another drive’s directory and then return to the drive on which URBNSTAL is located.)
3) Locate the file entitled SETUPEZ.BAT and double-click on it. This starts an installation program which automatically loads the URBEMIS7G program into a new folder that will be created off your root (‘C’) drive called URB7G.
4) *If you wish to install URBEMIS7G into a different folder or directory than the default location (for example “Urbemis7” on your C drive):* Using the Windows “Start” button, select “Run”. At the prompt, enter the drive and directory into which you previously downloaded the ‘URBNSTAL’ file from the Internet. Then type SETUPEZ followed by the location where you would like URBEMIS7G to be installed onto your computer. For example, if you downloaded the program from the Internet onto your “C” drive into a folder named “temp” and you want to install it onto your “C” drive in a file you wish to name ‘Urbemis7’, type the following after selecting “Run” from Start:

C:\temp\SETUPEZ C:\Urbemis7

(Note: when specifying a new folder or directory for Urbemis7G, the name must contain 8 or fewer characters.) Section II.4 below provides information on how to start the program once it has been installed.

a.3 Installing from the Internet Using MS-DOS:

1) If you wish to use MS-DOS instead of Windows, go to the ‘C’ root directory (into which you downloaded ‘URBNSTAL’ from the Internet). Then type URBNSTAL<enter>. This will extract the *Urbemis7G* program files. Then type SETUPEZ<enter> which starts a setup routine that will automatically install the URBEMIS7G program files into a new directory that will be created off your root (‘C’) drive, called ‘URB7G’.

2) *If you do <u>not</u> want the program to be installed at the default location (C:URB7G), and instead wish to specify another directory, then:* at the C prompt, type your preferred destination file name after typing SETUPEZ. For example, if you wish to install the program into a new directory named “Urbemis7” you would type:

SETUPEZ C:\Urbemis7 <enter>

(Please note: the name given to the destination directory must not exceed 8 characters in length, otherwise an installation error will result.) Once the program has been installed at a particular location, it can only be moved by following the procedure described in Section 11.3.2 below - under "Important Note" (or it can be reinstalled). After installation is complete, you may refer to Section II.4 on page 6 for information on how to start the program.

b. <u>Installing URBEMIS7G from Disks</u>

URBEMIS7G can be obtained on disk from the air district in California in which a development project to be analyzed is located. (Appendix F on page 79 of this Users' Guide includes information on air district contacts.) URBEMIS7G can be installed from disks either using Windows or MS-DOS, as follows:

b.1 Installing from Disks using Windows

1) *Using Windows Explorer:* Insert Disk 1 of 2 into drive A (or B). Select the 'A' drive (or 'B' drive) using Windows Explorer, 'My Computer" or File Manager. Then click on the "SETUP" file. This should start the setup routine, which will automatically install URBEMIS7G onto the 'C' drive in a file it will create named "URB7G". (The setup routine will prompt the user to install Disk 2 at the appropriate time.) Using this method, it is not possible to install URBEMIS7G at a different location on your computer. Once the program is installed in a particular location, it is not possible to move URBEMIS7G unless you follow the directions in Section 11.3.2 below - see "Important Note".

2) *If you wish to install URBEMIS7G into a different folder or directory than the default location (C:Urb7g):* Click on the Windows "Start" button (lower left corner). Select "Run" and at the prompt, type A: SETUP followed by the location where you would like URBEMIS7G to be installed onto your computer. For example, if you wish to install the program onto your "C" drive in a new file to be named 'URBEMIS7' you would type the following after selecting "Run" from the Start button:

A: SETUP C:\Urbemis7

(Note: when specifying a new folder or directory, the name must contain 8 or fewer characters.) Section II.4 on page 6 provides information on how to start the program once it has been installed.

b.2 Installing from Disks Using DOS

Insert Disk 1 of 2 into drive A or B. Then, to start the installation program from DOS or from a DOS window, change the default directory to drive A (or B) by typing A: <enter>. Next, type SETUP followed by the directory into which you would like to install URBEMIS7G. If you do not specify a destination, the installation routine will automatically create a new directory on the C drive called "URB7G" and will install the program at C:\URB7G. For example, to install URBEMIS7G on the 'C' drive into a different file (to be called "Urbemis7", for example), you would enter the following command at the A prompt:

```
A: \<enter>
     SETUP C:\URBEMIS7 <enter>
```

(Please note that the name given to the destination directory must not exceed 8 characters in length, otherwise an installation error will result.) This automatically starts the installation routine, which will prompt the user when it is time to insert Disk #2.

Once installation is complete, you may start URBEMIS7G by changing the default directory from A: to the location on the computer where URBEMIS7G has been installed, and type URB7G (or the new file name, such as 'Urbemis7') at the DOS prompt. For example, if the program has been installed at C:\URB7G, type:

```
C: <enter>
cd URB7G <enter>
URB7G <enter>
```

11.3.2 Installing URBEMIS7G Without Using the Installation Routine

This release of URBEMIS7G consists of three self-extracting files. The first self-extracting file is called URBIE.exe, which includes the main file (URB7G.exe) and seven supporting executable files (VEXE.exe, MITEXE.exe, CNSTCALC.exe, CONFORM.exe, AREACALC.exe, VEHEMIT.exe, and LANDEXE.exe). In addition, an eighth file, DIRECTRY.SAV is also included in URBIE.exe.

This installation procedure involves the creation of three subdirectories. First, at the C:\ prompt from within MS-DOS, create an URB7G subdirectory using the *MD* (make directory) command. Then, from within the URB7G subdirectory, create two subdirectories: C:\URB7G\PROJECTS and C:\URB7G\EMFAC7G. The URBEMIS7G files should be placed in these three newly created subdirectories. The URBEMIS7G executable files should be placed in the C:\URB7G subdirectory, and the EMFAC7G emission factor files should be placed in the C:\URB7G\EMFAC7G subdirectory. All project-related files should be placed in the C:\URB7G\PROJECTS subdirectory. To extract the files, copy URBIE.exe to the C:\URB7G subdirectory, set the default directory to C:\URB7G, and type *URBIE*. Eight files will be automatically extracted. (Once the files have been extracted onto your hard disk, the URBIE.exe file can be deleted.)

Important Note: The contents of the DIRECTRY.SAV file must match the directory locations of the URBEMIS7G executable, program, and EMFAC7G files. If they do not match, then URBEMIS7G will not be able to find all of the files it needs to run and will generate an error message.

The contents of the DIRECTRY.SAV file supplied with URBEMIS7G consist of four lines as follows:

```
directry.sav
"C:\URB7G\PROJECTS"
"C:\URB7G\EMFAC7G"
"C:\URB7G"
```

The second line tells URBEMIS7G where to look for project files, the third line where to look for the EMFAC7G files, and the forth line where to look for the URBEMIS7G executable files. If you install URBEMIS7G in a location that differs from that shown above, than you have one of two options. You can either delete the directry.sav file from your hard disk. If you do so, upon starting URBEMIS7G, you will be asked to specify the directory locations of your files before you can proceed with URBEMIS7G. The second option involves editing the directry.sav file to show the location of your files. If you edit the directry.sav file, you must remember to enclose your new directory locations within double quotes and to place the modified directry.sav file in the same location as the executable files.

The second self-extracting file, EMFAC7G.exe, includes all of the EMFAC7G emission files needed by URBEMIS7G. To extract the EMFAC7G emission files, copy EMFAC7G.exe to the C:\URB7G\EMFAC7G subdirectory, make C:\URB7G\EMFAC7G the default directory, and type *EMFAC7G*. A total of 28 EMFAC7G files will be extracted. These files represent EMFAC7G output for 14 years. A separate summer and winter EMFAC7G file is included for each year.

The third self-extracting file is called PROJECTS.exe. This file contains two sample project files that can be loaded and modified by the user. These two sample project files do not have to reside on disk for URBEMIS7G to operate. This file also contains 11 project files (".urb" extension) that contain default information for different geographic locations in California. URBEMIS7G will generate an error message if it cannot find these files in the projects subdirectory, although URBEMIS7G will still run. To extract the sample project files, copy PROJECTS.exe to the C:\URB7G\PROJECTS subdirectory, make C:\URB7G\PROJECTS the default directory, and type *PROJECTS* at the prompt.

II.4 Starting URBEMIS7G

URBEMIS7G can be started from within Windows; from a DOS window within Windows; or directly from the MS-DOS prompt. (Please refer to the remainder of this Users' Guide for information on using the program and documentation of its contents.)

Starting in Windows: * 1) Using "My Computer," "Windows Explorer," or "File Manager," locate the drive and the folder which contains URBEMIS7G (for example, you may select the 'C' drive and click on "URB7G" or "Urbemis7" -- or wherever the program was installed onto the computer). 2) Open this folder (by double-clicking on it). 3) Locate a file within it entitled "URB7G" and double-click on its file icon. This will automatically start URBEMIS7G, displaying the program's main menu.

Starting using MS-DOS: 1) At the DOS prompt, change to the drive and file where URBEMIS7G is located (for example, C:\URB7G or C:\Urbemis7). 2) To start the program, type ***URB7G*** <enter> and the program's main menu should be displayed.

Legal Disclaimer: Please click on this box on the menu and read it before using the program. (Please note: use of the program signifies agreement with this disclaimer.)

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* Note: it may be difficult to run URBEMIS7G from Windows version 3.1 due to memory constraints. If memory problems show up, or if the program crashes without reason, try exiting from Windows and freeing up more memory (see the discussion on memory limits in Section II.1 above.) If this doesn't help, you may need to run the program directly from the DOS prompt after closing down Windows.

III. USING URBEMIS7G

III.1 Differences from Previous Versions

III.1.1 Additions

Several versions of URBEMIS have been released by the California Air Resources Board (ARB) since the early 1980s: Urbemis1, Urbemis2, Urbemis3, and Urbemis5. (Urbemis4 was not released for use by the public.) Previous versions of URBEMIS allowed the user to estimate motor vehicle emissions associated with vehicle trips generated by land use development projects. Generally, each new release of URBEMIS has been associated with ARB's update of its motor vehicle emission factors.

URBEMIS7G represents the successor to URBEMIS5. URBEMIS7G is different from URBEMIS5 in several ways. First, URBEMIS7G is an updated version of URBEMIS5 because it includes EMFAC7G, ARB's California motor vehicle emission factors model.

Another difference is that, for the first time, URBEMIS7G provides users the ability to estimate construction and area-source emissions. Previous versions of URBEMIS did not offer these options. In addition, URBEMIS7G gives you the ability to select mitigation measures for construction, area-source, and motor vehicle emissions, another option not available in previous versions of URBEMIS. And, it provides estimates of the emissions benefits of those mitigation measures.

URBEMIS7G also includes a series of enhanced land use selection screens. The enhancements include additional land uses, updated trip generation rates, trip generation rates for certain land uses based on equations included in the ITE Trip Generation Manual Version 5.0 (Institute of Transportation Engineers 1991), and the option of specifying the rural versus urban component of each selected land use.

Previous versions of URBEMIS did not allow for estimation of reentrained road dust. URBEMIS7G estimates road dust emissions for both paved and unpaved roads.

URBEMIS7G also allows you to select a new "double-counting" option. This option is designed to minimize double counting of internal vehicle trips between residential and nonresidential land uses. Finally, URBEMIS7G allows the user to select a new "pass-by trips" option. With this option selected, URBEMIS7G estimates vehicle trip emissions based on the percentage of primary trips, diverted linked trips, and pass-by trips assumed for specific land use types.

III.1.2 Appearance

The appearance of URBEMIS7G is also substantially different from that of previous versions because it is now written in Microsoft's Visual Basic for DOS. Visual Basic for DOS allows the programmer to design forms used to accept user input.

III.1.3 Navigation

Navigation of URBEMIS7G's forms with a mouse and keyboard is limited by the rules of Visual Basic for DOS. Generally, movement of the cursor from one field to another within any form can be controlled by moving the mouse cursor and clicking the left mouse button. The cursor can also be moved from one field to another by the use of the tab key. Generally, the use of the arrow keys to move the cursor is not recommended because the arrow keys have a defined purpose in data entry fields. If the cursor is in a data entry field that accepts character or numeric input, the arrow keys can be used to move within the field but cannot be used to exit to another field. Finally, the insert versus typeover capabilities in URBEMIS7G are entirely dependent on the status of the insert key on the keyboard; the insert key can be pressed to change from insert to typeover or vice versa.

III.1.4 File Structure

URBEMIS7G uses a different file structure than previous versions of URBEMIS. Consequently, project files generated by previous versions of URBEMIS are not readable by URBEMIS7G. Attempting to read files from previous versions will generate an error message by URBEMIS7G. Similarly, project files created by URBEMIS7G cannot be read or used by earlier versions of URBEMIS.

III.2 Program Overview

Upon starting URBEMIS7G, you are taken to the URBEMIS7G main menu. The only exception to this is if, upon startup, URBEMIS7G cannot find the directory file (DIRECTRY.SAV) it needs to continue. In that case, URBEMIS7G bypasses the main menu and takes you to the "Set Directories" menu. At the "Set Directories" menu, you must enter the locations for specific file types needed by URBEMIS7G (see explanation in Section III.11, "Setting Directories").

From the main menu, you can begin by selecting either the "Begin New Project" or "Load Existing Project" options. Once you have selected one of those two options, URBEMIS7G loads a screen entitled: "Project Air Basin or Air District Location" (not shown in Figure 1). The user must enter the project location and is then taken to the "Select/Edit Land Uses and Emission Types" screen. This is the key screen for jumping off to land uses and emission types. From this screen, you have the option of entering land uses or jumping to the construction, area, or vehicle screen. For new projects, however, you must specify land uses before emission types can be selected.

III.3 Beginning a New Project

Upon starting URBEMIS7G, you are shown the URBEMIS7G main menu. You should ensure that the directories are set correctly (see Section III.11, "Setting Directories") before proceeding. Once directories have been set to your specifications, you should select "Begin a New Project" from the main menu.

At the "Begin a New Project" screen, you are prompted to enter the file name, project name, and project location. Project name and project location are optional; however, a file name must be entered. Once this information is entered, you can select OK or CANCEL. Hitting CANCEL returns you to the main menu without saving any information. Hitting OK sends you to the "Select/Edit Land Uses and Emission Types" screen, where you are prompted for additional information on the new project (see III.6, "Specifying Land Uses").

III.4 Loading an Existing Project

From the URBEMIS7G main menu, you should first ensure that the directories are set correctly (see Section III.11, "Setting Directories") before proceeding. To load an existing project from disk, select from the main menu the "Load an Existing Project" option. Selecting this option puts you into the "Load an Existing Project" screen. This screen shows the user all URBEMIS7G project files ending with the .urb extension on the selected project directory. To select a file, either double click the left mouse button on a file in the list or enter the file name at the top of the screen. If you attempt to hit OK without first entering a file name, URBEMIS7G flashes a message telling you to enter a file name before proceeding. If you enter a file name that does not exist in the selected directory, URBEMIS7G flashes a message telling you that the selected file does not exist. **Please note: URBEMIS7G uses a different file structure than previous versions of URBEMIS. If you attempt to load a file compatible with URBEMIS5 or earlier version, URBEMIS7G will generate an error message.**

III.5 Specifying Project Air Basin or Air District Location

Once an existing file has been specified or the name of a new project has been entered, URBEMIS7G takes the user to a screen entitled, "Project Air Basin or Air District Location". From this screen, the user is give the option of selecting one of up to ten air basins or air districts. In addition, URBEMIS7G allows the user to enter the name of an air basin or air district on the screen.

If the user is starting a new project, then selecting the correct air basin or air district location is important. For new projects, the selection of an air basin or air district retrieves default information appropriate for the project location.

III.6 Specifying Land Uses

Once you have entered a file name by beginning a new project or loading an existing project, you are sent to the "Select/Edit Land Uses and Emission Types" form. This form has a slightly different appearance depending on whether you are working with a new project or one that already exists on disk. If the project is new, then you must enter one or more land uses before the construction, area, or motor vehicle check box can be selected. If the project already exists (i.e., has been loaded from disk), you can modify the existing land uses that have already been entered but are not required to do so.

From the "Select/Edit Land Uses and Emission Types" screen, you must click on the "Select/Edit Land Uses" screen to enter land uses. URBEMIS7G then displays the first of six possible land use screens, which are organized as follows:

- residential land uses;
- schools, libraries, churches, and parks;
- health clubs, day care facilities, restaurants, hotels, and motels;
- retail land uses;
- banks and commercial office buildings; and
- industrial land uses.

Table 1 lists each of the land uses within URBEMIS7G, provides a definition of each land use, and shows the percent of trips associated with each land use made by those that work at that land use. Those percentages, called Percent Worker Commute in Table 1, are based on percentages for the same or similar land uses in previous versions of URBEMIS and on estimates of estimates of reasonable percentages for new land uses.

For each land use type, you are given the option of entering the unit amount and whether the land use is in a rural or urban location.* URBEMIS7G automatically calculates the trip rate based on the unit amount, using information taken from the ITE Trip Generation Manual, 5th edition (Institute of Transportation Engineers 1991 and 1995). The equation and average rates used to estimate trip generation are shown in Table 2. However, you can override the trip rate by typing in a different rate. For certain land uses, you also can select a different unit type by clicking on the “Unit Type” arrow (if it is shown for that particular land use). If a land use’s unit type does not have an arrow, then you can simply edit the name of the unit type. You can also edit the name of the land use type.

For all non-residential land uses, you also have the option of modifying the default “% Worker Commute” value. This value represents the percentage of worker commute trips attracted to that land use as a percentage of all trips generated by that land use.

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* “Dwelling unit” is a residential housing unit (including ‘single room occupancy’ units and ‘granny flats’). “Square feet” refers to the total floor area (on all levels) of buildings, but does not include parking structures even if they are within a building (also known as ‘gross leasable area’). “Acres” refers to the gross surface of the entire site, including any structures, streets, sidewalks, parking, and landscaping (but not including building or parking lot floor areas above the first level).

Table 1. Land Use Definitions and Percent Worker Commute

	Land Use Definition	Percent Worker Commute
First Land Use Screen		
Single Family Housing	Detached homes on individual lots	N/A
Apartments, Low Rise	Buildings with one to ten stories	N/A
Apartments, High Rise	Buildings with more than ten floors	N/A
Condo/Townhouse General	Condos and townhomes in buildings with one or two levels.	N/A
Condo/Townhouse High Rise	Condos and townhomes in buildings with 3 or more levels.	N/A
Retirement Community	Self-contained villages restricted to adults or senior citizens	N/A
Mobile Homes	Trailer homes sited on permanent foundations	N/A
Second Land Use Screen		
Elementary School	Generally includes Kindergarten through either 6th or 8th grades.	20
Junior High School	Includes 7th, 8th, and often 9th grades.	20
High School	Includes 10th, 11th, and 12th grades and oftentimes 9th grade.	10
Junior College (2 years)	Most have facilities separate from other land uses and exclusive access points and parking facilities.	5
University/College (4 years)	Four year and graduate educational institutions.	5
Library	Public or private facility which houses books, and includes reading rooms and possibly meeting rooms.	5
Place of Worship (weekend) Place of Worship (weekday)	Building(s) providing public worship services.	3 3
Blank (Edit all 5 columns)	Blank commercial land use that can be entered by the URBEMIS7G user.	2

Third Land Use Screen		
Racquet Club	Privately owned facilities with tennis, racquetball, and/or handball courts, exercise rooms, and/or swimming pools and/or weightrooms	5
Racquet/Health Club	Privately owned facilities with tennis, racquetball, and/or handball courts.	5
Day-Care Center	Facilities that care for pre-school children, normally during daytime hours. May also include after-school care for older children.	5
Quality Restaurant	Typically with customer turnover rates of at least one hour.	8
High Turnover (sit-down Restaurant)	Typically with high customer turnover rates of less than one hour.	5
Fast Food Restaurant with Drive Through	Includes fast food restaurants with drive through windows, such as McDonald's, Burger King, and Taco Bell.	5
Fast Food Restaurant without Drive Through	Includes fast food restaurants without drive through windows, such as McDonald's, Burger King, and Taco Bell.	5
Hotel	Place of lodging providing sleeping accommodations, restaurants, and meeting or convention facilities.	5
Motel	Place of lodging providing accommodations and often, a restaurant.	5
Fourth Land Use Screen		
Free-Standing Discount Store	Free-standing store with off-street parking, can be part of neighborhood shopping centers.	2
Free-Standing Discount Superstore	Same as free-standing discount store but also include full service grocery department under the same roof.	2
Discount Club	Discount/warehouse store whose shoppers pay a membership fee to take advantage of discounted prices.	2
Regional Shopping Center > 57,000 Square Feet	Integrated group of commercial establishments that are planned, developed, owned, and managed as a unit.	2
Regional Shopping Center < 57,000 Square Feet	Integrated group of commercial establishments that are planned, developed,	2

	owned, and managed as a unit.	
Supermarket		2
Convenience market (24 hour)	These markets sell convenience foods, newspapers, etc. and do not have gasoline pumps. (Trip generation rates with gas pumps is approximately 12% higher than without.	2
Convenience market with gas pumps	These markets sell convenience foods, newspapers, etc. and do have gasoline pumps.	2
Gasoline/Service Station	Excludes gasoline stations with convenience stores or car washes.	2
Fifth Land Use Screen		
Warehouse	Buildings devoted to the storage of materials, also include office and maintenance areas.	2
Bank (with drive-through)	Banks with one or more drive-up windows.	2
General Office Building	Houses multiple tenants in a location where affairs of businesses, commercial or industrial organizations or professional persons or firms are conducted.	35
Office Park	Contain general office buildings and related support services, arranged in a park- or campus-like setting.	48
Government Office Building	Individual building containing the entire function or simply one agency of a city, county, state, or federal government.	10
Government (Civic Center)	Group of government buildings connected with pedestrian walkways	10
Medical Office Building	Includes both medical and dental office buildings that provide diagnoses and outpatient care. Generally operated by one ore more private physicians or dentists.	7
Hospital	Any institution where medical or surgical care is give to non-ambulatory and ambulatory patients and overnight accommodations are provide.	25

Sixth Land Use Screen		
General Light Industry	Typical light industrial activities include: print	50

	plants, material testing labs, and assemblers of data processing equipment. They employ fewer than 500 persons and tend to be free-standing.	
General Heavy Industry	Could also be categorized as manufacturing facilities. However, heavy industrial uses are limited to the production of large items.	90
Industrial Park	Contain a number of industrial or related facilities and are characterized by a mix of manufacturing, service, and warehouse facilities. May contain highly diversified facilities, a number of small businesses, or one or two dominant industries.	41.5
Manufacturing	Sites where the primary activity is the conversion of raw materials or parts into finished products. May also included associated office, warehouse, research, and other functions.	48

Percent worker commute represents the percentage of total trips that are work-related commute trips.

Table 2. URBEMIS7G Trip Generation Rates			
Land Use	**Trip Generation Rate Fitted Curve Equation or Average Rate**	**X or Units ***	**Source**
Single Family Housing	Ln(T) = 0.921 Ln(X) + 2.698	Dwelling Unit	ITE (210)
Apartment, Low Rise	Ln(T) = 0.821 Ln(X) + 2.898	Dwelling Unit	ITE (211)
Apartment, High Rise	T = [(0.218/X) + 0.00002]**-1	Dwelling Unit	ITE (222)
Condominium/Townhouse, General	Ln(T) = 0.850 Ln(X) + 2.565	Dwelling Unit	ITE (230)
Condominium/Townhouse, High Rise	Ln(T) = 0.927 Ln(X) + 1.924	Dwelling Unit	ITE (232)
Mobil Home Park	Ln(T) = 0.890 Ln(X) + 2.162	Dwelling Unit	ITE (240)
Retirement Community	3.3	Dwelling Unit	ITE (250), 4th Ed.
Elementary School	Ln(T) = 0.718 Ln(X) + 3.496	1000 sq. ft.	ITE (520)
Elementary School	T = [(1.113/X) - 0.00002]**-1	Student	ITE (520)
High School	Ln(T) = 0.721 Ln(X) + 3.759	1000 sq. ft.	ITE (530)
High School	T = [(0.420/X) + 0.00027]**-1	Student	ITE (530)
Church (Sunday Trip Rate)	36.6	1000 sq. ft.	ITE (560)
Church (Weekday Trip Rate)	9.3	1000 sq. ft.	ITE (560)
Racquet Club	17.1	1000 sq. ft.	ITE (492)
Racquetball/Health Club	40	1000 sq. ft.	SANDAG
Day-Care Center	79.3	1000 sq. ft.	ITE (565)
Quality Restaurant	Ln(T) = 0.900 Ln(X) + 4.746	1000 sq. ft.	ITE (831) Update
High-Turnover (Sit-Down) Restaurant	177.9	1000 sq. ft.	ITE (832) Update
Fast-Food Restaurant w/o Drive-Through Window	T = [(0.00121/X) + 0.00002]**-1	1000 sq. ft.	ITE (833) Update
Hotel	T = 8.802(X) - 59.208	Occupied Room	ITE (310)
Motel	Ln(T) = 1.065 Ln(X) + 1.983	Occupied Room	ITE (320)
Free-Standing Discount Store	T = 96.770(X) - 4216.699	1000 sq. ft.	ITE (815) Update
Regional Shopping Ctr. >570,000 sq. ft. GLA	Ln(T) = 0.756 Ln(X) + 5.154	1000 sq. ft.	ITE (820)
Regional Shopping Ctr. <570,000 sq. ft. GLA	Ln(T) = 0.625 Ln(X) + 5.985	1000 sq. ft.	ITE (820)
Supermarket	178	1000 sq. ft.	ITE(850)
Convenience Market (24 hr.)	738	1000 sq. ft.	ITE (851)
Warehouse	0.12	1000 sq. ft.	ITE(152)
Bank (with Drive-Through)	Ln(T) = 0.562 Ln(X) + 6.181	1000 sq. ft.	ITE (912)
General Office Building	Ln(T) = 0.756 Ln(X) + 3.765	1000 sq. ft.	ITE (710)
Office Park	Ln(T) = 0.835 Ln(X) + 3.435	1000 sq. ft.	ITE (750)
Government Office Building	68.9	1000 sq. ft.	ITE (730)
Government (Civic Center)	30	1000 sq. ft.	SANDAG
Medical Office Building	Ln(T) = 1.178 Ln(X) + 2.777	1000 sq. ft.	ITE (720)
Hospital	Ln(T) = 0.591 Ln(X) + 5.205	1000 sq. ft.	ITE (610)
Hospital	Ln(T) = 0.634 Ln(X) + 4.628	Bed	ITE (610)

Table 2. URBEMIS7G Trip Generation Rates

Land Use	Trip Generation Rate Fitted Curve Equation or Average Rate	X or Units *	Source
General Light Industry	T = 7.468(X) - 101.921	1000 sq. ft.	ITE (110)
General Light Industry	T = 42.223(X) + 263.112	Acre	ITE (110)
General Light Industry	T = 2.951(X) + 30.572	Employee	ITE (110)
General Heavy Industry	1.5	1000 sq. ft.	ITE (120)
General Heavy Industry	6.8	Acre	ITE (120)
Industrial Park	T = 4.949(X) + 765.587	1000 sq. ft.	ITE (130)
Industrial Park	T = 47.913(X) + 598.220	Acre	ITE (130)
Industrial Park	Ln(T) = 0.796Ln(X) + 2.572	Employee	ITE (130)
Manufacturing	T = 3.883(X) - 13.112	1000 sq. ft.	ITE (140)
Junior High School	40	Acre	SANDAG
Junior High School	1.0	Student	SANDAG
Junior College (2 Years)	80	Acre	SANDAG
Junior College (2 Years)	1.6	Student	SANDAG
University/College (4 Years)	T = 2.355(X) + 31.862	Student	ITE (550)
Library	Ln(T) = 0.364 Ln(X) + 6.093	1000 sq. ft.	ITE (590)
Fast-Food Restaurant with Drive-Through Window	710.1	1000 sq. ft.	ITE (834) Update
Free-Standing Discount Superstore (1)	T = 59.492(X) - 1930.270	1000 sq. ft.	ITE (813) Update
Discount Club (2)	42.6	1000 sq. ft.	ITE (861) Update
Convenience Market with Gasoline Pumps	845.6	1000 sq. ft.	ITE (853) Update
Gasoline /Service Station	174.7	Acre	ITE (844) Update
Neighborhood Park (undeveloped)	5	Acre	SANDAG

Notes

T = Average Vehicle Trip Ends
sq. ft. = Square Feet
GLA = Gross Leasable Area
N/A = Data Not Available
SANDAG = San Diego Association of Governments

* "Dwelling unit" is a residential housing unit (including 'single room occupancy' units and 'granny flats'). "Square feet" refers to the total floor area (on all levels) of buildings, but does not include parking structures even if they are within a building (also known as 'gross leasable area'). "Acres" refers to the gross surface of the entire site, including any structures, streets, sidewalks, parking, and landscaping (but not including building or parking lot floor areas above the first level).

(1) Similar to the free-standing discount stores with the exception that the superstores also contain a full service Grocery department.

(2) A discount store/warehouse whose shoppers pay a membership fee in order to take advantage of discounted Prices.

III.7 Construction Emissions

III.7.1 Specifying Construction Emissions

The construction emission screen allows you to estimate area-source emissions for up to seven categories of emission sources. Two of these categories, demolition and site grading, are often called Phase I emission sources. The remaining five categories are often called Phase II emission sources. The current version of URBEMIS7G totals all construction emissions; it does not total emissions separately by phase. The construction source main menu also has an area that allows you to enter the year and length of construction period for which construction emissions are being estimated. The emission factors used by URBEMIS7G to estimate construction emissions are described in detail in Appendix A.

From the construction emissions main menu, you can click on the emission sources for which emission estimates are desired. You can also click on the settings button for any of the seven construction categories.

For example, clicking on the site grading button takes you to the site grading emissions menu. You may then modify any of the settings, which will be saved by clicking on the OK button. A similar procedure can be used to review or modify the settings for each of the construction emission sources.

Note that the settings for demolition require you to enter information in the "Demolition Emissions Settings" screen. If you check the demolition box, indicating that you want URBEMIS7G to estimate demolition emissions, URBEMIS7G will indicate demolition emissions of zero unless you provide information on the total volume and maximum daily volume of the buildings to be demolished.

III.7.2 Specifying Construction-Related Mitigation Measures

From the construction emissions menu, you can select construction mitigation measures by selecting "Mitigate Construction" and hitting the "Edit Const. Settings..." button. This action takes you to the first "Construction Mitigation Measures" screen. From this screen, you can select from a number of preprogrammed construction source mitigation measures for site grading and unpaved roads. From this menu, if you can click the next screen button, URBEMIS7G shows you preprogrammed mitigation measures for building construction, construction worker trips, architectural coatings, and asphalt paving. The efficiencies assumed for each of the pre-programmed construction measures are shown in Table 3.

You can also add up to 10 additional construction source mitigation measures by selecting "Add New Construction Measures" and hitting the "Go Add/Edit/Delete" button. You are then taken to the "Additional Construction Source Mitigation Measures" screen where you are required to enter, for each measure you want to add, the measure name, measure type, and percentage emission reduction for reactive organic gases (ROG), nitrogen oxides (NOx), inhalable particulates (PM10), and carbon monoxide (CO). The measure type is limited to one of eight construction emission

Table 3. Construction Emission Mitigation Measures

		Emission Reduction (%)				
Emission Source	Mitigation Measure	ROG	NOx	PM10	CO	Source
Site Grading - Equipment Exhaust	Proper equipment maintenance	5.0	5.0	5.0	N/A	(SMAQMD 1994)
Site Grading - Active Disturbance	Water exposed surface two times per day	-	-	37.0	N/A	(SMAQMD 1994)
Site Grading - Active Disturbance	Water exposed surface two times per day	-	-	68.0	N/A	(SMAQMD 1994)
Site Grading - Active Disturbance	Water exposed surface to keep soil moist at all times	-	-	75.0	N/A	(SMAQMD 1994)
Site Grading - Active Disturbance	Apply non-toxic soil stabilizers to all inactive construction areas	-	-	65.0	-	(SCAQMD 1993)
Site Grading - Active Disturbance	Replace ground cover in disturbed areas quickly	-	-	49.0	-	(SCAQMD 1993)
Unpaved Roads	Water all haul roads twice daily	-	-	3.0	N/A	(SMAQMD 1994
Unpaved Roads	Water all haul roads three times per day	-	-	85.0	N/A	(SCAQMD 1993)
Unpaved Roads	Pave all haul roads	-	-	92.5	N/A	(SCAQMD 1993)
Unpaved Roads	Reduce speeds on all unpaved roads to 15 mph or less	-	-	70.0	N/A	(SCAQMD 1993)
Stationary Equipment	Proper equipment maintenance	5.0	5.0	5.0	N/A	(SMAQMD 1994
Building Construction - Mobile Equipment Exhaust	Proper equipment maintenance	5.0	5.0	5.0	N/A	(SMAQMD 1994
Building Construction - Mobile Equipment Exhaust	Use methanol or natural gas equipment instead of diesel	54.0	-29.0	95.0	25.0	(SCAQMD 1993)
Building Construction - Mobile Equipment Exhaust	Use propane or butane powered equipment instead of diesel	53.0	-53.0	18.0	96.0	(SCAQMD 1993)
Construction Worker Trips	Develop/implement trip reduction plan to achieve 1.5 AVR	2.2	2.9	2.9	2.9	(SCAQMD 1993)
Construction Worker Trips	Implement shuttle to and from retail establishments @ lunch	1.0	1.3	1.3	1.3	(SCAQMD 1993)
Architectural Coatings	Use coatings with VOC content less than compliance levels	5.0	-	-	-	(NO REFERENCE)
Asphalt Paving	Use asphalt with VOC content less than compliance levels	5.0	-	-	-	(NO REFERENCE)

types: site grading equipment, site grading dust, unpaved roads, mobile equipment exhaust, stationary equipment exhaust, construction worker trips, architectural coatings, and asphalt paving.

III.8 Area Source Emissions

III.8.1 Specifying Area Emissions

The “Area-Source Emission” screen allows you to estimate area-source emissions for up to five categories of emission sources. Four of these five categories are fuel combustion related: natural gas, wood stoves, fireplaces, and landscape maintenance. The fifth, consumer products, includes only reactive organic compound emissions released through the use of products such as hair sprays and deodorants. The emission factors used by URBEMIS7G to estimate area-source emissions are described in detail in Appendix B.

From the “Area Source” main menu, you can click on the sources to obtain whichever emission estimates are desired. You can also click on the settings button for any of the six area-source emission categories to review or change the default settings used by URBEMIS7G to estimate emissions for that category.

For example, by clicking on the fuel combustion-natural gas settings button, you are taken to the “Natural Gas Combustion Settings” menu. You may then modify any of the settings, which will be saved by clicking on the OK button. A similar procedure can be used to review or modify the settings for each of the area emission sources.

Note that the setting for fuel combustion-landscape maintenance requires you to enter the year being analyzed. This year does not have to match the year entered for construction or motor vehicle emissions.

III.8.2 Specifying Area-Source Mitigation Measures

From the “Area Source” main menu, you may select area-source mitigation measures by selecting “Mitigate Area” and hitting the “Settings...” button. This action takes you to the “Area Source Mitigation Measures” screen. From this screen, you can select a number of preprogrammed area-source mitigation measures for residential, commercial, and industrial sources. The efficiencies of the preprogrammed area source mitigation measures are shown in Table 4.

You can also add up to 10 additional area-source mitigation measures by selecting “Add New Area Source Measures” and hitting the “Go Add/Edit/Delete” button. You are then taken to the “Additional Area-Source Mitigation Measures” screen, where you are required to enter, for each measure, the measure name, measure type, and percentage emission reduction for ROG, NOx, PM10, and CO. The measure type is limited to one of seven types: residential space heating, residential water heating, residential landscape maintenance, commercial space heating, commercial water heating, commercial landscape maintenance, and industrial space heating.

Table 4. Area Source Emissions Mitigation Measures

Emission Source	Mitigation Measure	Emission Reduction (%)				Source
		ROG	NOx	PM10	CO	
Residential Water Heaters	Use solar or low-emission water heaters	11	9.5	4.5	10	(SCAQMD 1993)
Residential Water Heaters	Use central water heating systems	9	8	4	8.5	(SCAQMD 1993)
Residential Heating	Orient buildings to the north for natural cooling and heating	14	13	10.5	13.5	(SCAQMD 1993)
Residential Heating	Increase walls and attic insulation beyond Title 24 requirements	14	13	7.4	13	(SCAQMD 1993)
Commercial Water Heaters	Use solar or low-emission water heaters	0.5	0.5	0.5	0.5	(SCAQMD 1993)
Commercial Water Heaters	Use central water heating systems	0.5	0.5	0.5	0.5	(SCAQMD 1993)
Commercial Heating	Orient buildings to the north for natural cooling and heating	11	13.5	17.5	12.5	(SCAQMD 1993)
Commercial Heating	Increase walls and attic insulation beyond Title 24 requirements	10	9	7	9.5	(SCAQMD 1993)
Industrial Heating	Orient buildings to the north for natural cooling and heating	2	3	2.5	5.5	(SCAQMD 1993)
Landscape Maintenance - Residential	Project provides electric maintenance equipment	100	100	100	100	(no reference)
Landscape Maintenance - Commercial	Project provides electric maintenance equipment	100	100	100	100	(no reference)

III.9 Vehicle-Source Emissions

III.9.1 Specifying Vehicle Emissions

The “Settings for Operational-Related Emissions” screen shows eight separate check boxes (excluding the mitigation check box) that represent information needed to estimate motor vehicle emissions. The first six of these boxes (vehicle fleet percentages, target year, trip characteristics, temperature data, variable starts, and road dust) must be checked to obtain motor vehicle emissions. The remaining two check boxes (pass-by trips and double counting) are optional check boxes that do not have to be checked to obtain motor vehicle emission estimates. The double counting check box does not appear unless the user has indicated a mixed use project by entering both a residential and a non-residential land use in the land use selection screens.

Note that neither the “Settings for Operational-Related Emissions” screen nor any of its supporting screens allow you to specify the season (winter or summer) for which you want to estimate emissions. URBEMIS7G automatically estimates motor vehicle emissions for both winter and summer of the target year using the temperature data specified in the temperature data screen. You are given the option of printing either summer or winter emission estimates in the output screens (see discussion under Section III.10).

The vehicle fleet percentages can be modified by clicking on the “Settings” button, which takes you to the “Vehicle Fleet Characteristics” screen. From this screen, you can modify any of the fleet percentages or fuel/technology classes. Once you are satisfied with the information, you can return to the previous screen by hitting the “OK” button.

The target year can be modified by clicking on the “Target Year Settings” button, which takes you to the “Target Year” screen. You need only click on the year for which you would like to estimate emissions.

The “Trip Characteristics” screen can be modified by clicking on the “Settings” button from the “Settings for Operational-Related Emissions” screen. Several pieces of information are contained in the “Trip Characteristics” screen: average trip speeds, trip percentages, and trip lengths for five different trip types (home-based work trips, home-based shopping trips, home-based other trips, work trips, and commercial-based non-work trips).

Note that the “Trip Characteristics” screen allows you to enter the trip percentages for home-based trips, which must total 100 percent. However, this same screen does not permit you to enter trip percentages for commercial-based trips. Instead, commercial-based percentages are calculated separately by URBEMIS7G for each nonresidential land use selected in the “Land Use” screens (see Section III.6).

The “% Worker Commute” information from the land use screens corresponds to the commercial-based commute work trip value. The commercial-based commute trip percentage is then used to estimate commercial-based non commute work trip and customer based trip percentages for each land use. If the commercial-based commute trip value exceeds 50 percent, then the commercial-based non commute trip percentage equals 100 percent minus the commute trip percentage, multiplied by 50 percent. If the commercial-based commute trip value is less than 50 percent, then the commercial-based non commute trip percentage equals one half of the commercial-based commute trip value. Finally, for each land use, customer based trips are assumed to equal the 100 percent minus the total of the commercial commute and non commute percentages.

The “Trip Characteristics” screen also allows you to modify default percentages for urban and rural trip lengths by trip type. For each land use type selected on the land use screens, you are given the option of identifying the land use as either urban or rural. If you have identified the land use as urban, then the urban trip lengths are used to estimate vehicle miles traveled and, ultimately, emissions. In contrast, if you have identified a land use a rural, then the rural trip lengths are used. Once you are satisfied with the trip characteristics, clicking the “OK” button sends you back to the “Settings for Operational-Related Emissions” screen.

From the “Settings for Operational-Related Emissions” screen, you can modify default temperature data by clicking on the temperature data settings button. From within the “Temperature Data” screen, you have the option of modifying both winter and summer ambient temperatures. These temperatures are used to estimate winter and summer emission estimates and correspond to the summer versus winter gasoline specifications used in California outside of the South Coast Air Basin (greater Los Angeles). Selecting “OK” from the “Temperature Data” screen returns you to the “Settings for Operational-Related Emissions” screen.

You may modify the “Variable Starts” information by clicking on the “Variable Starts” settings button shown on the “Settings for Operational-Related Emissions” screen. You are then taken to a screen entitled “Variable Start Percentages by Trip Type and Time since Engine Stopped”. The information contained in this screen is new for URBEMIS7G and represents a significant change from previous versions of URBEMIS, corresponding to a change in ARB’s EMFAC emission factors. Previous versions of EMFAC (EMFAC7F1.1 and earlier) required that the percentages of cold and hot starts be provided. In contrast, EMFAC7G requires the vehicle engine shut-off percentages for 12 time increments, ranging from 1 minute to 720 minutes. The information provided in this screen by trip type represents statewide averages of pre-start cool-down profiles from an ARB analysis of the 1991 California Department of Transportation household travel survey. These percentages should not be modified unless better information is available.

You may modify the “Road Dust” information by clicking on the “Road Dust” settings button on the “Settings for Operational-Related Emissions” screen. You are then taken to a screen that reads “Entrained Road Dust Emissions”. You then have the option to modify the distribution of travel between paved and unpaved roads. You also have the option modify the paved road or unpaved road defaults by clicking on the appropriate button.

If you click on the “Change Paved Road Defaults...” button, you are taken to the “Paved Road Dust Emissions” screen. From within that screen, you may modify the default emission factors and percentage of travel for each of four road types.

You may also click on the “Change Unpaved Road Defaults...” button, where URBEMIS7G will display the “Unpaved Road Dust Emissions” screen. From this screen, you can select either the U.S. EPA methodology for calculating emissions or you can use the California Air Resources Board’s emission factor. If you select the U.S. EPA methodology, you are allowed to modify one or more of the five variables used to estimate unpaved road dust emissions.

From the “Settings for Operational-Related Emissions” screen, you may choose to check the double-counting box. The double-counting adjustment is designed to reduce double counting of internal trips between residential and nonresidential land uses. Consequently, selecting this option is viable only when you have selected both residential and nonresidential land uses. You must click the settings button where URBEMIS7G displays the “Double Counting Adjustment of Multiple Land Use Projects” screen. At this screen, you are asked whether you would like to adjust for internal trips between residential and nonresidential land uses. If you click on the “No” button, URBEMIS7G returns to the “Settings for Operational-Related Emissions” screen. If you click on the “Yes” button, then you are taken to the “Double Counting Adjustment” screen.

From the “Double Counting Adjustment” screen, you are provided with one of two options: direct input of the number of internal trips or program-generated estimate of internal trips. If you select the first option, then URBEMIS7G takes you to the “Double Counting Adjustment” screen. At this screen, you are shown the number of residential and nonresidential trips that would be generated based on the land uses selected. You are given the option of entering the number of internal trips between residential and nonresidential land uses. The value entered represents the number of internal trips that will not be included in the emissions estimate. Once you are comfortable with the internal trip estimate, clicking on the “OK/Return” button returns to the “Settings for Operational-Related Emissions” screen.

If you select the second option, “Program-Generated Estimate of Internal Trips”, from the “Double Counting Adjustment” screen, then URBEMIS7G presents the “Urbanized Context” screen. You must then identify how the proposed project fits into its urbanized context. This information is then used to provide suggested default information on the next screen, “Remaining User Input for Double Counting Correction”. On this final double-counting correction screen, URBEMIS7G presents suggested default percentages for three trip types: work trips, shopping trips, and other trips. Once you have entered the desired percentages, then clicking on the “OK” button returns you to the “Settings for Operational-Related Emissions” screen.

From the “Settings for Operational-Related Emissions” screen, you may select the “Pass-By Trips” button, although no optional “Settings” button is available. Selecting the “Pass-By Trips” button allows URBEMIS7G to calculate emissions from vehicle trips that are generally lower than estimates without the pass-by trip option. The pass-by trip algorithm is described in Appendix C.

III.9.2 Specifying Vehicle-Related Mitigation Measures

From the “Settings for Operational-Related Emissions” screen, you have the option of specifying operational mitigation measures. These can be specified by selecting the “Mitigate Operational Emissions” check box and clicking on the “Settings” button. You are then taken to the “Set Travel Mode Environment” screen.

The Vehicle-Related Mitigation Measures component may not be approved for use in your air basin. Contact your local air district representative if you have any questions regarding its use (many are listed in Appendix E). Documentation for this component is provided in Appendix D.

The following is an overview of the steps you will go through to utilize the Mobile Mitigation Component. A more detailed description follows the overview.

URBEMIS7G MOBILE SOURCE MITIGATION COMPONENT
Step by Step Description

Step 1. **Select Measures to View:** User selects whether to view residential, non-residential, or both types of measures. If residential is selected, the program will display only residential mitigation measures. If non-residential is selected, the program will display only non-residential mitigation measures. If both are selected, the program will display all mitigation measures.

Step 2. **Select Environmental Conditions:** User selects either to use default environmental conditions and transit service or to go through the list of environmental factors for pedestrian environment, transit service, and bicycle environment. The defaults are set at a level achievable by a standard suburban automobile oriented subdivision or commercial development.

Step 3. **Select Mitigation Measures:** User selects mitigation measures from groups of measures that would increase usage of alternative modes, i.e., transit measures, bicycle measure, commute trip measures, etc.

Step 4. **Calculate Trip Reduction Percentages:** The program adds the reductions from each category of measure and reduces the total based on the environmental factors and presents this quantity in the final report.

Step 5. **Adjust Percentages by Trip Type and for Trip Length:** The program will add all reductions by measure types (transit, pedestrian, bike, and other). The program then adjusts the amount by a correction factor to account for differences in effectiveness for different types of trips (H-W, H-S, H-O, W, N-W emp, N-W customer). A second correction factor adjusts the pedestrian and bicycle reductions to account for the shorter trips being replaced by these modes.

Step 6. **Calculate Emission Reductions:** The program takes the adjusted trip reduction percentages and reduces the trips generated by the URBEMIS trip generation component. The new, lower trip generation rate is then multiplied by the emission factors to calculate emissions.

Step 7. **Calculate VMT Reductions:** The program will multiply VMT reduced by the running emission factor and then subtract the amount from total emissions.

Step 8. **Produce Reports:** The program generates a report listing the environmental and transit service factors selected, mitigation measures selected, percent reductions for each mitigation type, and percent reduction for each trip type. The final results will provide unmitigated project emissions, amount mitigated, and mitigated project emissions.

The Vehicle-Related Mitigation Measures component allows you to calculate emission reductions achieved by applying mitigation measures to a project. In order to account for the variability in effectiveness of mitigation measures due to environmental conditions, the program requires you to set environmental factors that affect the measures. The percent reduction listed on the screen for each measure represents the maximum achievable under ideal conditions. The environmental factors reduce this amount in an internal calculation to arrive at the actual percent reduction.

The first screen you will encounter is the “Set Travel Mode Environment Screen.” This screen allows you to select either a default environment or to set the environment using a series of screens describing the conditions affecting travel in and around the project site. The default environment is based on an automobile oriented suburban area with no transit service. If you select the default environment you are then taken to the mitigation measure selection screens which will be described later. If you select the set environment option you are taken to the “Pedestrian Environment Factor” screen.

From the “Pedestrian Environment Factor” screens you must select from three levels of coverage for seven different factors affecting pedestrian travel. Guidance for determining the level of coverage for each factor is provided in the Mitigation Handbook. After you have selected a level for each factor, the program adds the points selected and then divides this number by the total points possible to arrive at the Pedestrian Environment Factor (PEF). The program then takes you to the “Transit Environment Factor” screen.

From the “Transit Environment Factor” screen you must select the highest level of transit service serving the project site. In some cases, this may be the planned level of service as indicated in an approved transit plan. Once you have selected the level of transit service, you are taken to the “Bicycle Environment Factor” screen.

The “Bicycle Environment Factor” screens are similar to the PEF screens. You must select from three possible levels of coverage corresponding basically to high, medium, or low for each of six different factors. Once you have completed these screens, you are taken to the mitigation measure selection screens.

The first mitigation measure selection screen is “Transit Enhancing Infrastructure Measures.” The screen is divided into two sections, Project Description Items and Developer Measures. Project Description Items are items that provide a benefit just because of the projects location or design. Developer Measures are physical improvements and infrastructure provided or funded by the developer. These are the more traditional mitigation measures. The first possible selection is for the Project Description Item “Project Density Meets Transit Level of Service Requirement.” This may be determined by comparing the current or planned level of transit service with the numbers in Appendix D, Table D-3 and D-4. Next, select each Developer Measure that will be applied to the project. The program allows the program user to include other mitigation measures not listed, however the total percent reduction allowed may not exceed the predetermined maximum shown on the screen.

The next mitigation measure selection screen is “Pedestrian Enhancing Infrastructure Measures (Residential).” If you selected both residential and non-residential land uses on the first screen, you will see separate screens for residential and non-residential mitigation measures for enhancing pedestrian travel. The first user selection is a credit for “Mixed Use Project (Residential Oriented)” in the Project Description Items section. A definition of “Mixed Use” can be found in the Mitigation Handbook. Next you must select the Developer Measures that will be applied to the project from those listed or you may add new measures.

The “Pedestrian Enhancing Infrastructure (Non-Residential)” screen includes Project Description Items for Mixed Use Project (Commercial) and for Floor Area Ratio (FAR) .75 or greater. Select Project Description Measures and Developer Measures or add measures as with the previous screens.

The “Bicycle Enhancing Infrastructure Measures” screens are next. No user selected Project Description Measures are provided. Select developer measures or add new measures as with the previous screens.

The next set of screens cover Operational Measures. These are measures that an employer or building owner would implement to reduce trips. The first set of measures apply to employee commute trips. The screens are designed somewhat differently than the infrastructure measure screens. Charging for parking has three different levels to choose from based on cost to the employee. Select the appropriate parking charge or skip if free parking is provided. Measures for telecommuting and compressed work schedule require the user to enter the percent of the workforce participating in the program.

The next screen is for “Operational Measures (Applying to Employee Shopping Trips and Errands).” Select all measures that will apply to the project. A measure for providing onsite shops and services allows three levels of credit based on the number of services provided at the worksite. See the mitigation handbook for guidance on making this selection.

The next screen is for “Operational Measures (Applying to Customer/Client Trips).” Select from the customer parking charge that will apply to the site, if any, or add user measures as with the previous screens.

The final set of screens apply to “Measures Reducing Vehicle Miles Traveled (VMT)” for non-residential and residential projects. Provide the number of park and ride spaces or telecommuting workstations that will be provided by the developer. Any user measures added for these categories require you to enter the VMT estimated to be reduced.

After the last mitigation measure screen is completed, the program returns you to the “Set Travel Mode Environment” screen. Here you have the option of accepting the input you just made, returning you to the “Setting for Operational-Related Emissions,” or revising your environment and mitigation settings. The program also allows you to go backwards through the environment and mitigation screens to make changes by clicking on the previous screen button.

III.10 Outputting and Saving Results

To view emissions output or save a project to disk, you must select the “Output and/or Save Results” option from the main menu. Selecting this option sends you to the “Output Results of Current Project” screen.

This screen allows you to select one of three output options or to save the current project to a disk file. Each of these options is described in more detail below.

III.10.1 Outputting to the Screen

You may view current project emissions on the computer screen by selecting the “Output Results to Screen” option and then selecting either the summary or detailed report and the type of output units (pounds per day for summer or winter or tons per year). Clicking the “Begin Output/Save” button tells URBEMIS7G to show the results on the computer screen. URBEMIS7G then shows construction, area, or vehicle emissions, depending on whether the construction, area, or operation boxes have been checked in the “Select/Edit Land Uses and Emission Types” screen (see also Sections III.6, III.7, and III.8).

III.10.2 Saving to a File

To save information to a computer file, you must select the "Output Results to a File" option and then select either the summary or detailed report and the type of output units (pounds per day for summer or winter or tons per year). Clicking the "Begin Output/Save" button then sends you to the "Write Output to Disk" screen. You must either select an existing output file from a list or type in the name of the new file. The output file must end with the ".out" extension. The emissions output is then saved with the entered name on the project files directory once you click the "OK" button. Clicking the "OK" button tells URBEMIS7G to print to a file the information on emissions for construction, area, or vehicle emissions, depending on whether the construction, area, or operation boxes have been checked in the "Select/Edit Land Uses and Emission Types" screen (see also Sections III.6, III.7, and III.8). The file is saved on the land use project files default drive specified in the "Set Default Drives and Directories" menu, which is accessible from the URBEMIS7G main menu.

III.10.3 Printing to a Printer (Hard Copy)

You may choose to send project emissions estimates to a printer by selecting the "Output Results to Printer" option and then selecting either the summary or detailed report and the type of output units (pounds per day for summer or winter or tons per year). Clicking the "Begin Output/Save" button tells URBEMIS7G to send the results to the printer. URBEMIS7G will then print construction, area, or vehicle emissions, depending on whether the construction, area, or operation boxes have been checked in the "Select/Edit Land Uses and Emission Types" screen (see also Sections III.6, III.7, and III.8).

III.10.4 Saving the Project File on Disk

Saving the project file to a disk is essential if you want to rerun the program later. To save a file, select from the "Output Results of Current Project" screen the "Save the Current Project to a Disk File" option and click the "Begin Output/Save" button.

This button sends you to the "Save Current Project" screen. This screen presents you with a list of existing project files, each ending with the ".urb" extension. You may then use the mouse to select one of the existing project files by putting the cursor on the desired file name and double clicking the left mouse button. Alternatively, you may enter the file name by typing it into the file name field. Once a file name has been entered, you must click the "OK" button to save the file to the default land use project files directory.

Several file names are reserved. Those reserved names contain default information associated with various air basins or air districts. The user cannot save a file using a reserved file name without entering the appropriate password, which are set by the individual air districts. Consequently, if you try to save a file to disk and URBEMIS7G prompts you for a password, you have selected a reserved file name. Hit the cancel key and try entering a different filename.

If you click "OK", the file is saved and you are returned to the "Output Results of Current Project" screen. If you click the "Cancel" button instead, the selected file is not saved and you are returned to the "Output Results of Current Project" screen.

III.11 Setting Default Drives and Directories

Setting the correct default drives and directories is essential to running URBEMIS7G successfully. Three sets of files are included with URBEMIS7G: land use project files, emission rate files, and executable or "*.exe" files.

At startup, the program looks for a file called DIRECTRY.SAV on the default drive. The DIRECTRY.SAV file tells URBEMIS7G the default drives and directories. If URBEMIS7G finds the DIRECTRY.SAV file, then the program loads the main menu. If URBEMIS7G cannot find the DIRECTRY.SAV file, then the program immediately sends you to the "Set Default Drives and Directories" screen.

Once there, you are prompted to select a default drive and directory for each of the three sets of files. To select a default drive or directory, you must position the cursor on the appropriate drive or directory and double click the left mouse button. Make sure that the three sets of directories are on the same drive; otherwise, the program will not run properly.

Once drives and directories have been selected, you must either press "OK" or "Cancel". Pressing "OK" saves the newly selected drives and directories to the DIRECTRY.SAV file. Pressing "Cancel" takes you back to the main menu without saving any changes to the DIRECTRY.SAV file. The "Cancel" button will not work if the DIRECTRY.SAV file does not exist on disk in the default executable directory, which is the program from which the program is started.

III.12 Exiting the Program

You must exit URBEMIS7G from the main menu. Before exiting, however, remember to save your most recent file modifications. While running, the URBEMIS7G program creates a series of temporary files with the "*.tmp" extension. These files are created in the default project files directory and are automatically erased upon exiting URBEMIS7G.

If, for whatever reason, you exit URBEMIS7G abnormally, then one or more files with the ".tmp" extension may not be erased from the default project files directory. You can erase them manually; otherwise, URBEMIS7G looks for any such files at startup and erases them.

References

California Air Resources Board. 1995a. Emission inventory 1993. Technical Support Division. Sacramento, CA.

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Institute of Transportation Engineers. 1991. Trip generation. 5th edition, Washington, DC.

Institute of Transportation Engineers. 1995. Trip generation February 1995 update to the 5th edition. Washington, DC.

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Appendix A. Construction Emissions

Construction Emissions

URBEMIS7G allows users to generate estimates of construction emissions (inhalable particulate matter [PM10], carbon monoxide [CO], reactive organic gases [ROG], and oxides of nitrogen [NOx]).

Construction emissions are estimated for:

demolition ,
site grading equipment exhaust and fugitive dust,
construction worker vehicle trips,
asphalt paving,
stationary equipment
mobile equipment, and
architectural coatings.

Demolition Emissions

If the user chooses to estimate construction emissions, the user will be prompted to select the types of construction emissions that they would like to estimate. If the user selects demolition emissions, then the user is prompted to enter the number of buildings that will be demolished.

For each building to be demolished, the following equation is used to estimate PM10 generated by demolition:

$$\text{PM10 (pounds/day)} = (0.00042 \text{ pounds of PM10 / feet}^3) * (N * O * P) / Q.$$

Where: N = building width (feet)
O = building length (feet)
P = building height (feet)
Q = number of days required to demolish the building(s).

This equation is based on Table A9-9-H of the South Coast Air Quality Management District's (SCAQMD's) California Environmental Quality Act (CEQA) Air Quality Handbook (South Coast Air Quality Management District 1993).

URBEMIS7G does not provide default information on building dimensions slated for demolition. The user must provide URBEMIS7G with that information to estimate demolition emissions. The user has the option of entering building width, length, and height or entering total building volume. The user also is required to enter the number of days required to demolish the building(s). A default of 10 days is used if the user does not know the demolition period.

Site Grading Emissions

Grading Equipment Exhaust

Site grading emissions consist of two components: grading equipment exhaust and grading-related fugitive PM10 dust. Each component is described below.

The procedure used to estimate site grading equipment exhaust emissions is based on emission factors developed by U.S. Environmental Protection Agency (EPA) (U.S. Environmental Protection Agency 1985). The mobile construction equipment equations proposed for URBEMIS7G are based on the following equation:

Emissions (pounds/day) = (pounds of pollutant emitted per hour [from Table A-1]) * (hours per day for each equipment type operated)

Table A-1 summarizes the mobile construction equipment emission factors that URBEMIS7G uses. For example, if construction involves the use of a wheeled loader for 8 hours per day, total PM10 emissions would equal 1.36 pounds PM10 per day (0.17 pounds PM10 per hour * 8 hours per day).

As a default, URBEMIS7G assumes that one tracked loader, one wheeled loader, and one motor grader (all diesel powered) are needed for each 10 acres of land disturbed. That is, for any amount of land disturbance up to 10 acres, those three pieces of equipment each would be used for 8 hours per day. And, if the project construction would disturb anywhere from 11 to 20 acres, six pieces of equipment are assumed to be used (two of each type), each for 8 hours per day.

URBEMIS7G estimates a default acreage graded per day based on the land use sizes specified by the user. For single-family residential units, URBEMIS7G assumes five units per acre. For multifamily units, URBEMIS7G assumes 20 units per acre. For commercial uses, URBEMIS7G assumes that the acreage equals twice the size of each building's square footage. For example, URBEMIS7G assumes that a 100,000 square foot industrial park would require 200,000 square feet (4.6 acres) of land disturbance. URBEMIS7G assumes that only 25% of total land acreage slated to be disturbed will actually be disturbed on the worst-case day. The user has the option of modifying the total acreage estimates generated by URBEMIS7G.

The user has the option of conducting more detailed estimates if additional construction information is available. By selecting the Equipment Exhaust option in the "Site Grading Emissions" menu, the user is prompted to specify the number of pieces of each equipment type (of those shown in Table A-1) and the total hours per day that the equipment would be used. URBEMIS7G takes that information and provide estimates of daily ROG, NOx, and PM10 emissions. The user also is prompted to enter the total number of days in which earth moving would be conducted during the construction period. This information is used to estimate total annual emissions. URBEMIS7G defaults to 250 days if the user does not provide an estimate.

Fugitive Dust

The equation used to estimate fugitive dust PM10 emissions is based on the emission factor prepared by the ARB for construction activities

PM10 (pounds/day) = (220 pounds of PM10 / acre-month) * (month / 22 days) * Acres graded per day

The PM10 emission factor of 220 pounds per acre-month is based on a report prepared for the South Coast Air Quality Management District (Midwest Research Institute, 1995). The acres graded per day is based on the same acreage estimates generated for estimating grading equipment exhaust. Annual emissions are estimated using the same number of days of construction activity as was used to estimate grading equipment exhaust. The end user and the District can modify each of the variables included in the fugitive dust equation.

Construction Worker Vehicle Trips

Emissions from construction worker vehicle trips are estimated by multiplying total daily employee vehicle miles traveled (VMT) by an emission rate (grams per mile). URBEMIS7G estimates construction-related employee trip generation as follows. Each land use type selected as part of the project is grouped into one of four general land use categories: multifamily, single-family, commercial/retail, and office/industrial. Then, for each category, the number of trips is estimated using the following equations:

Multifamily Trips = 0.36 trips/unit * number of units
Single-Family Trips = 0.72 trips/unit * number of units
Commercial or Retail Trips = 0.32 trips/1,000 feet^2 * number of 1,000 feet^2
Office or Industrial Trips = 0.42 trips/1,000 feet^2 * number of 1,000 feet^2

These trip generation rates are based on information contained in the Sacramento Metropolitan Air Quality Management District's Air Quality Thresholds of Significance Handbook (Sacramento Metropolitan Air Quality Management District (1994).

URBEMIS7G then totals trips from the four general land use categories and multiplies by the average trip length to obtain daily VMT. The user has the option of altering trip length. URBEMIS7G uses the construction year identified by the user (in the "Settings for Construction-Related Emission" screen) to select EMFAC emission rates that will be multiplied by VMT/day. The length of the construction period is used to estimate annual Phase II construction emissions for construction worker vehicle trips, stationary equipment, and mobile equipment.

Asphalt Paving

URBEMIS7G estimates ROG emissions associated with asphalt paving. The emissions are estimated based on the procedure identified in the SMAQMD manual (Sacramento Metropolitan Air Quality Management District 1994). ROG emissions are estimated using the following formula:

ROG (pounds per day) = (2.62 pounds ROG / acre) * (total acres paved / paving days)

URBEMIS7G assumes that 50% of the gross acreage identified in the grading dust emission estimates will be paved and that paving will take 10 days. The user can modify these assumptions by entering the number of acres to be paved and the number of days required to complete the paving.

Stationary Equipment

URBEMIS7G estimates stationary equipment construction emissions of ROG, NOx, and PM10 from machinery such as generators. These estimates are based on the following equations:

ROG (pounds per day) = 0.168 pounds of ROG per unit (or thousands of $feet^2$)
* Number of units (or thousands of $feet^2$)

NOx (pounds per day) = 0.137 pounds of NOx per unit (or thousands of $feet^2$)
* Number of units (or thousands of $feet^2$)

PM10 (pounds per day) = 0.008 pounds of PM10 per unit (or thousands of $feet^2$)
* Number of units (or thousands of $feet^2$)

These equations are based on the SMAQMD's manual and assume two pieces of gasoline powered equipment per each 10 units or 10,000 $feet^2$. The equipment is assumed to be used 6 hours per day and averages 10 horsepower each (Sacramento Metropolitan Air Quality Management District 1995). The number of housing units and/or the square footage of building construction used to estimate stationary equipment emissions is based on the land use types entered by the user.

Mobile Equipment

The procedure used to estimate mobile equipment emissions is similar to that used for grading equipment exhaust emissions. The mobile construction equipment equations included in URBEMIS7G are based on the following equation.

Emissions (pounds/day) = (pounds of pollutant emitted per hour [from 1]) *
(hours per day for each equipment type operated)

Table A-1 summarizes the mobile construction equipment emission factors used by URBEMIS7G. URBEMIS7G estimates mobile equipment construction emissions of ROG, NOx, and PM10 from mobile equipment such as fork lifts and dump trucks.

As with the site grading equipment emissions, the number of housing units and/or the square footage of building construction is used to estimate the default amount of equipment used. As a default, URBEMIS7G assumes that two pieces of mobile equipment (one fork lift and one dump truck) are used 8 hours per day for any amount of construction up to 10 units or 10,000 $feet^2$ (Sacramento Metropolitan Air Quality Management District 1994). The default amount of mobile source equipment is assumed to double for each doubling in the size of the land use. Thus, construction of from 11 to 20 units or 10,001 to 20,000 $feet^2$ would require four pieces of construction equipment. The equipment is assumed to be diesel powered and used 8 hours per day.

Table A-1. Mobile Construction Equipment Emission Factors

	ROG (lbs/hr)		NOx (lbs/hr)		PM10 (lbs/hour)	
Equipment Type	Gas	Diesel	Gas	Diesel	Gas	Diesel
Fork Lift 50 HP	0.05	0.053	0.018	0.441	0.003	0.031
Fork Lift 175 HP	1.53	0.17	0.92	1.54	0.123	0.093
Truck: Off Highway	-	0.19	-	4.17	-	0.26
Tracked Loader	-	0.095	-	0.83	-	0.059
Tracked Tractor	-	0.12	-	1.26	-	0.112
Scraper	-	0.27	-	3.84	-	0.41
Wheeled Dozer	-	-	-	-	-	0.165
Wheeled Loader	0.515	0.23	0.0518	1.9	0.03	0.17
Wheeled Tractor	0.351	0.18	0.43	1.27	0.024	0.14
Roller	0.59	0.065	0.362	0.87	0.026	0.05
Motor Grader	0.4	0.039	0.32	0.054	0.021	0.061
Miscellaneous	0.543	0.15	0.412	1.7	0.026	0.14

Source (U.S. Environmental Protection Agency 1985; SMAQMD 1995)

The user has the option of conducting more detailed estimates if additional information is available. By selecting the Mobile Equipment Settings Diesel and/or Gas buttons, the user is prompted to specify the number of pieces of each equipment type (of those shown in Table A-1) and the total hours per day that equipment would be used. URBEMIS7G takes that information and provides estimates of daily and annual ROG, NOx and PM10 emissions.

Architectural Coatings

URBEMIS7G estimates ROG emissions resulting from the evaporation of solvents contained in paints, varnishes, primers, and other surface coatings. Separate procedures are used to estimate evaporative emissions from application of residential and nonresidential architectural coatings. The following emission factors are used for residential coating emissions:

ROG (pounds / day) = ((0.0185 pounds of ROG per foot^2 surface area) * ((Number of single-family units * square feet per unit) + (Number of multi-family units * square feet per unit)) * 2.7)) * mil thickness) / (number of days + 3)

The following equation is used for estimating nonresidential architectural coatings emissions:

ROG (pounds/day) = (((0.0185 pounds ROG / foot^2 surface area) * (Sum of Individual Building Square Footage * 2.0)) * mil thickness) / (Number of Days to Paint + 3)

For the residential equation, the factor 2.7 is used to convert building area to surface area. For nonresidential coatings, the value of 2.0 is used to convert building area to surface area. URBEMIS7G assumes that twenty days will be required to complete the painting and drying takes an additional 3 days. URBEMIS7G also assumes that single-family homes average 1,800 feet^2 and multifamily homes average 850 feet^2. The number of units to be painted is based on land use information provided by the user.

The URBEMIS7G calculation assumes a ROG emission rate of 0.0185 pounds of ROG per square foot, which represents a waterborne coating assumed to have 47.67 percent by weight solids, 10.54 pounds per gallon density, 250 grams per liter VOC content, and a coating thickness of one mil (0.001 inch).

The user has the option of altering the ROG emission rate, paint thickness, conversion ratio (building area to surface area), and the number of days required to complete the painting.

Appendix A References

Midwest Research Institute (MRI). 1995. Improvement of Specific Emission Factors (BACM Project No. 1) Draft Final Report. Prepared for the South Coast AQMD. November 14, 1995. Kansas City, MO.

Sacramento Metropolitan Air Quality Management District. 1994. Air quality thresholds of significance, first edition. Sacramento, CA.

South Coast Air Quality Management District. 1993. CEQA air quality handbook. Diamond Bar, CA.

U.S. Environmental Protection Agency. 1985. Compilation of air pollutant emission factors, volume I: stationary, point, and area sources, and volume II: mobile sources, fourth edition. Research Triangle Park, North Carolina.

Appendix B. Area Source Emissions

Area Source Emissions

URBEMIS7G has been enhanced so that both novice and experienced users can generate accurate estimates of area source emissions. Novice users can generate estimates using default assumptions programmed into URBEMIS7G. Users experienced in estimating area source emissions can modify the area source assumptions to suit their particular project.

URBEMIS7G allows the user to estimate area source emissions from:

- fuel combustion emissions from space and water heating, including wood stoves and fireplaces;
- fuel combustion emissions from landscape maintenance equipment; and
- consumer product ROG emissions.

FUEL COMBUSTION EMISSIONS FROM WATER AND SPACE HEATING

Natural Gas Combustion

URBEMIS7G can be used to estimate fuel combustion emissions from water and space heating using the approach described in Tables A9-12, A9-12-A, and A9-12-B in the South Coast Air Quality Management District CEQA handbook (South Coast Air Quality Management District 1993) and emission factors developed by the U.S. Environmental Protection Agency (U.S. EPA 1995). With one exception, all emission estimates assume natural gas is used as the primary source of water and space heating. The one exception is wood used for fireplaces and wood stoves. The equation used to estimate CO, ROG, NOx, and PM10 emissions from natural gas combustion is as follows for each land use type:

$$\text{Emissions} = H * (\{[F*G]/30\}/1{,}000{,}000) * P$$

Where: H = emission factor for each criteria pollutant in pounds of pollutant per million cubic feet of natural gas consumed (CO: 40 pounds/MMfoot^3; ROG: 7.26 pounds/MMfoot^3; NOx: 94.0 pounds/MMfoot^3 [residential], NOx 100.0 pounds/MMfoot^3 [nonresidential]; PM10: 0.18 pounds/MMfoot^3)

F = units per land use type: residential (number of units)
industrial (customers)
hotel/retail/office (square feet)

G = Natural gas usage rates:

Residential: Single-Family: 6,665.0 feet^3 / unit / month
Multifamily: 4,011.5 feet^3 / unit / month

Nonresidential: industrial: 241,611 feet^3 / customer / month
hotel/motel: 4.8 feet^3 / square feet / month

retail/shopping: 2.9 $feet^3$ / square feet / month
office: 2.0 $feet^3$ / square feet / month

P = percentage using natural gas

Residential 100%
Nonresidential 100%

Wood Combustion –Wood Stoves

Wood stove emissions can be estimated using the following equation:

Wood Stove Emissions (pounds per day) = ((A * C) + (B * D) + (E * F) + (J * K)) * (G) * (H * I)

Where:

A = EPA-certified noncatalytic stove emission rate (grams pollutant per ton of kilogram wood burned)
B = EPA-certified catalytic stove emission rate (grams pollutant per kilogram of wood burned)
C = Percent of all stoves assumed to be noncatalytic
D = Percent of all stoves assumed to be catalytic
E = Conventional wood stove emission rate (grams pollutant per kilogram wood)
F = Percent of all stoves assumed to be conventional
G = Cords of wood burned per year per residential unit
H = Number of residential units
I = Percentage of residential units with wood stoves
J = Pellet stove emission rate (grams pollutant per kilogram wood burned)
K = Percent of all stoves assumed to be pellet

URBEMIS7G assumes the following defaults for wood stove emissions:

A = 9.8 grams PM10 / kilogram, 70.4 grams CO / kilogram, 7.5 grams ROG / kilogram, 1.4 grams NOx / kilogram
B = 10.2 grams PM10 / kilogram, 52.2 grams CO / kilogram, 7.8 grams ROG / kilogram, 1.0 grams NOx / kilogram
C = 50% (entered as 0.50)
D = 50% (entered as 0.50)
E = 15.3 grams PM10 / kilogram, 115.4 grams CO / kilogram, 21.9 grams ROG / kilogram, 1.4 grams NOx / kilogram
F = 0.0%
G = 1.48 cords per year per residential unit
H = based on land uses specified by the user
I = 35% (entered as 0.35)
J = 2.1 grams PM10 / kilogram, 19.7 grams CO / kilogram, 0.01 grams ROG / kilogram, 6.9 grams NOx / kilogram
K = 0.0%

The emission factors shown above are based on EPA's AP-42 document (U.S. Environmental Protection Agency 1995). The emission factor assumes an even split between noncatalytic, catalytic, and pellet stoves. The default assumption assumes that no conventional nor stoves will be included, although the equation will allow the user to include conventional stoves in the emission calculation. Annual emissions assume 2.71 tons wood (1.48 cords) would be burned per stove per residential unit during the heating season.

Wood Combustion –Fireplaces

Fireplace emissions are estimated using the following equation:

Fireplace Emissions (pounds per day) = (J * K * L * M)

Where:

J = Fireplace emission rate (pounds of pollutant per residential unit per ton of wood burned)
K = Cords of wood burned per day year residential unit
L = Number of residential units
M = Percentage of residential units with wood stoves

URBEMIS7G will assume the following defaults for fireplace emissions:

J = 34.6 pounds of PM10 / ton, 252.6 pounds of CO / ton, 229.0 pounds of ROG / ton, 2.6 pounds of NOx / ton
K = 1.48 cords burned per year per residential unit
L = residential units are based on the residential land uses specified by the user
M = 10% (entered as 0.10)

These emission rates are based on information published by EPA (U.S. Environmental Protection Agency 1995). As with wood stove emissions, the user can modify each of the variables used to estimate fireplace emissions. Annual emissions are estimated based on annual wood combustion.

FUEL COMBUSTION EMISSIONS FROM LANDSCAPE MAINTENANCE

Landscape maintenance equipment generates emissions from fuel combustion and from evaporation of unburned fuel. Emissions include NOx, ROG, CO, and PM10. Equipment in this category includes lawn mowers, roto tillers, shredders/grinders, blowers, trimmers, chain saws, and hedge trimmers used in residential and commercial applications. This category also includes air compressors, generators, and pumps used primarily in commercial applications (California Air Resources Board 1992a).

The California Air Resources Board has enacted regulations to limit emissions from landscape maintenance equipment (California Air Resources Board 1992b). Beginning in 1994 these regulations impose emission limits on all landscape maintenance equipment sold. Those regulations become more stringent for equipment sold in 1999 and later. Consequently, the emissions from this source category are similar to automobile emissions in that the turnover in the equipment fleet plays an important part in how quickly emission reductions are achieved.

URBEMIS7G estimates emissions from this source category based on the year in which the user is attempting to estimate emissions. The California Air Resources Board has prepared estimates of emissions in 1989 and emission reductions expected by 2010. The proposed equations for this source category are divided into residential and commercial categories. The residential equation applies only to SFHU. The commercial equation is based on emissions per business unit and includes multifamily residential land uses.

<u>1989 Emissions - Residential</u>
ROG (pounds/day) = 0.003 pounds ROG / SFHU/day * SFHU
CO (pounds/day) = 0.024 pounds CO / SFHU/day * SFHU
NOx (pounds/day) = 0.0002 pounds NOx / SFHU/day * SFHU
PM10 (pounds/day) = 0.00006 pounds PM10 / SFHU/day * SFHU

<u>1989 Emissions - Commercial</u>
ROG (pounds/day) = 0.175 pounds ROG / Business Unit * Number Business Units
CO (pounds/day) = 1.149 pounds CO / Business Unit * Number Business Units
NOx (pounds/day) = 0.007 pounds NOx / Business Unit * Number Business Units
PM10 (pounds/day) = 0.0041 pounds / PM10 Business Unit * Number Business Units

<u>2010 Emissions - Residential</u>
ROG (pounds/day) = 0.00054 pounds ROG / SFHU/day * SFHU
CO (pounds/day) = 0.00576 pounds CO / SFHU/day * SFHU
NOx (pounds/day) = 0.00014 pounds NOx / SFHU/day * SFHU
PM10 (pounds/day)= 0.000005 pounds PM10 / SFHU/day * SFHU

<u>2010 Emissions - Commercial</u>
ROG (pounds/day) = 0.0315 pounds ROG / Business Unit *Number Business Units
CO (pounds/day) = 0.276 pounds CO / Business Unit * Number Business Units
NOx (pounds/day) = 0.005 pounds NOx / Business Unit * Number Business Units
PM10 (pounds/day)= 0.00037 pounds PM10 / Business Unit * Number Business Units

The residential emission factors shown in the 1989 emission equations are based on total residential emissions from this source category in the San Joaquin Valley divided by the San Joaquin Valley's total 1989 SFHUs. Similarly, the commercial emission factors for 1989 are based on total San Joaquin Valley commercial emissions divided by the Valley's total 1989 business units (U.S. Department of Commerce 1991). For the commercial equations, URBEMIS7G bases the number of business units on the number of non single-family housing land uses specified by the user.

The 2010 emission rates are based on ARB's estimates that, by 2010, the regulation will reduce ROG emissions by 82%, CO by 76%, PM10 by 91%, and NOx by 28%.

The regulations for this source category take effect in 1994 and become more stringent in 1999. URBEMIS7G will use the emission rates shown for 1989 for 1990 through 1993. For 1994 through 2009, URBEMIS7G will use interpolated emission factors by assuming a uniform decrease in the emission rate each year. In 2010 and succeeding years, the 2010 emission rates will be used.

Average annual emissions assume that daily emissions would occur only during the summer period of 180 days. The end user will be able to modify the length of the summer period.

CONSUMER PRODUCT EMISSIONS

Consumer product emissions are generated by a wide range of product categories, including air fresheners, automotive products, household cleaners, and personal care products. Emissions associated with these products primarily depend on the increased population associated with residential development (California Air Resources Board 1990). Consequently, URBEMIS7G can be used to estimate consumer product emissions when one or more residential land uses have been selected by the user. Emissions would be based on the following equation:

ROG (pounds/day) = 0.0171 pounds of ROG per person * Number of residential units * 2.861 persons per unit

The ROG emission factor is based on the total estimated ROG emissions from consumer products divided by the total California population (California Air Resources Board 1990; California Department of Finance 1994). Persons per household is based on the 1990 census information for California (California Department of Finance 1994).

URBEMIS7G will base the number of residential units on information provided by the user on residential land uses. The user can modify each of the variables in the ROG emissions equation.

Annual emissions are estimated by multiplying pounds of ROG emitted per day by 365 days per year.

Appendix B References

California Air Resources Board. 1990. Proposed regulation to reduce volatile organic compound emissions from consumer products, staff report. Sacramento, CA.

California Air Resources Board. 1992a. Attachment C. technical support document for California exhaust emission standards and test procedures for 1994 and subsequent model year utility and lawn and garden equipment engines.

California Air Resources Board. 1992b. Attachment A. Sections 28 and 29 of the California exhaust emission standards and test procedures for 1994 and later utility and lawn and garden equipment engines.

California Department of Finance. 1994. California statistical abstract. Sacramento, CA.

South Coast Air Quality Management District. 1993. CEQA air quality handbook. Diamond Bar, CA.

U.S. Department of Commerce. 1991. County business patterns 1989 California. Bureau of the Census, Washington, DC.

U.S. Environmental Protection Agency. 1995. AIR CHIEF CD-ROM Version 4.0. Research Triangle Park, North Carolina.

Appendix C. Operational (Motor Vehicle) Emissions

Exhaust Emission Factors

URBEMIS7G estimates vehicle exhaust emissions using several pieces of input supplied by the user. That information is entered in the series of operational emission screens incorporated into URBEMIS7G. URBEMIS7G then calls the appropriate summertime and wintertime EMFAC7G files based on the analysis year selected by the user.

Based on information supplied by the user, URBEMIS7G selectively reads portions of the EMFAC7G file. After the EMFAC7G file has been read, URBEMIS7G calculates criteria pollutant emissions for:

- running exhaust (grams per mile of ROG, CO, NOx, PM10),
- tire wear particulates (grams per mile, PM10),
- brake wear particulates (grams per mile, PM10),
- variable starts (grams per trip, ROG, CO, NOx),
- hot soaks (grams per trip, ROG),
- diurnals (grams per hour, ROG) ,
- resting losses (grams per hour, ROG), and
- evaporative running losses (grams per mile, ROG).

Two of these emission categories, running exhaust and variable starts, are also adjusted by a temperature correction factor included as part of EMFAC7G. Once emission rates have been obtained from EMFAC7G (and corrected), URBEMIS7G generates estimates for other key data needed to estimate emissions, such as miles traveled, number of trips, or number of hours. This key data is then multiplied by the appropriate emission factors, adjusted to obtain the correct units (pounds per day and tons per year), and sent to a temporary file that can be viewed by the user.

Entrained Road Dust Emissions

Entrained road dust emissions are generated by vehicles traveling on both paved and unpaved roads. URBEMIS7G provides end users with a default percentage of VMT for paved versus unpaved roads. End users are asked whether they want to modify those percentages. Default percentages assume that 100 percent of VMT occurs on paved roads and 0 percent on unpaved roads.

Paved Roads.

For paved roads, URBEMIS7G uses the following equation:

PAVED = [(LOCAL * LOCPER) + (COLLECT * COLPER) + (MAJOR * MAJPER) + (FREEWAY * FREEPER)] * [VMT * PAVEPER]

Where:

LOCAL = PM10 emission factor for local streets (0.018 pounds / VMT)
LOCPER = percentage of travel on local streets
COLLECT = PM10 emission factor for collector streets (0.013 pounds / VMT)
COLPER = percentage of travel on collector streets
MAJOR = PM10 emission factor for major streets/highways (0.0064 pounds / VMT)
MAJPER = percentage of travel on major streets

FREEWAY = PM10 emission factor for freeways/expressways (0.00067 pounds / VMT)
FREEPER = percentage of travel of freeways
VMT = total vehicle miles traveled
PAVEPER = percent of VMT on paved roads (default equals 100)

URBEMIS7G is programmed to ensure that LOCPER, COLPER, MAJPER, and FREEPER total to 100 percent and that PAVEPER and UNPAVEPER also total to 100 percent. The default percentages equal 0.129 for LOCPER, 0.119 for COLPER, 0.500 for MAJPER, and 0.252 for FREEPER, based on 1993 travel fractions for California (California Air Resources Board 1997).

This equation is based on the recommended particulate emission factors for specific roadway categories found in AP-42 (U.S. Environmental Protection Agency 1995). The user has the option of modifying each of the five percentages shown in the equation.

Unpaved Roads.

The unpaved road equation is as follows:

$$UNPVD = [PSDUNP * 5.9 * (UNSILT / 12.0) * (SPD / 30.0) * (WEIGHT / 3.0)^{0.7} * (VWHEEL / 4.)^{0.5} * (365 - IPDAYS) / 365] * [VMT * UNPAVEPER]$$

Where:

UNPVD = the fleet average unpaved road dust emissions (pounds/day)
PSDUNP = the fraction of particles less than or equal to the particle size cutoff
UNSILT = the percent silt content of the surface material (input by the user)
SPD = the average vehicle speed (mph, input by the user)
WEIGHT = the fleet average vehicle weight (tons, input by the user in lbs.)
VWHEEL = the fleet average number of wheels (input by the user)
IPDAYS = the average number of precipitation days per year with greater than 0.01 inches of rain (input by the user)
VMT = total vehicle miles traveled per day
UNPAVEPER = percentage of VMT on unpaved roads

This equation is based on EPA's emission factor equation for unpaved roads (U.S. Environmental Protection Agency 1995).

PSDUP = 0.36 (for the 10 microns and under particle size cutoff)
UNSILT = 4.3 % (allowable range [4.3 - 20 %])
SPD = 40 miles per hour (allowable range [13 - 40 mph])
WEIGHT = 3 tons (allowable range [3 - 157 tons])
VWHEEL = 4 wheels (allowable range [4 - 13 wheels])
IPDAYS = zero days rain for worst case day, 40 days per year of annual estimate
VMT = generated by URBEMIS
UNPAVEPER = 0.0

The user will be allowed to modify all values except PSDUP. Annual emissions would be estimated by multiplying daily emissions by 365 days per year.

Minimize Double Counting for Multiuse Projects and Pass-By Trips

This discussion is divided into two sections: double counting of multiuse projects and double counting of pass-by and diverted link trips.

Double Counting of Multiuse Projects

URBEMIS7G contains a procedure that reduces double counting of internal trips in a mixed-use project or community plan area. The procedure only applies when at least one residential and one non-residential land use are specified by the URBEMIS7G user and the user selects the double-counting correction algorithm.

Because trip generation rates account for both trip productions and attractions, adding the gross trip generation for two land uses in a project double counts the trips between them. The procedure described below is designed to count the internal trips only once.

The user has the option of selecting either the direct input of the percentage of internal trips or a program-generated estimate of internal trips. If the user selects the direct input approach, URBEMIS7G displays a screen showing the number of residential and nonresidential trips. Then the user is prompted to enter the gross internal trip number, which limits the number of internal trips estimated by URBEMIS7G.

The gross internal trip limit reported by the program is based on a comparison of residential trips versus nonresidential trips; the smaller of the two is the limiting value.

Alternatively, the user selects the program-generated estimate of internal trips. Under this option, the user is first asked to identify the project site in relation to its urbanized context.

Suggested default percentages for internal trips by trip purpose are determined by the urbanization context of the project. Usually, the suggested default percentage for work trips is lower than the suggested default percentage for shopping and other trips. The suggested defaults for a major component of a metropolitan area are higher than the suggested defaults for a minor component of a metropolitan area. If the urbanization context of the project is an isolated rural development, the suggested defaults equal 100%. Note that unless residential and nonresidential land uses are perfectly balanced in gross trip generation, there will always be some external trips in the final program computations.

URBEMIS7G uses the following defaults for performing the double counting adjustment:

Isolated Trip Type	Isolated Development	Minor Component	Major Component
Residential		*percentages*	
Home-Work	100	10	30
Home-Shop	100	20	50
Home-Other	100	20	50
Non-Residential			
Work	100	10	30
Non-Work	100	20	50

As presented above, the proposed double-counting correction is applied only to trips between residential and nonresidential land uses. A small amount of double counting may remain for trips between different residential land uses.

Based on the user's response, URBEMIS7G presents information internal trip limits based on trip types and prompts the user to estimate the percentage of those trips that are internal to the project (i.e., the percentage that are double counted).

The internal trip double-counting correction procedure is based on the selected land use categories and associated trip generation rates. Residential trips by trip purpose are compared with nonresidential trips by trip purpose to establish limits on the internal trip adjustments.

Once information has been entered in URBEMIS7G, total trips are adjusted by the following formula:

$$\textit{Net Trips} = \text{Gross Total Trips} - (0.5 \times \textit{Gross Internal Trips})$$

This equation can also be presented as follows:

$$\textit{Net Trips} = \textit{External Trips} + \textit{Net Internal Trips}$$

where:

$$\textit{External Trips} = \textit{Gross Total Trips} - \textit{Gross Internal Trips}$$

$$\textit{Net Internal Trips} = (0.5 \times \textit{Gross Internal Trips}).$$

Double Counting of Pass-By Trips

An important deficiency in URBEMIS5 is that it does not account for pass-by trips and diverted linked trips. According to the Institute of Transportation Engineers' (ITE) document Trip Generation, 5th Edition (ITE 1991), vehicle trips associated with a trip generator can be divided into three categories:

- *Primary Trips* are trips made for the specific purpose of visiting the generator. The stop at that generator is the primary reason for the trip. For example, a home to shopping to home combination of trips is a primary trip set.

- *Pass-By Trips* are trips made as intermediate stops on the way from an origin to a primary trip destination. Pass-by trips are attracted from traffic passing the site on an adjacent street that contains direct access to the generator. These trips do not require a diversion from another roadway.

- *Diverted Linked Trips* are trips attracted from the traffic volume on roadways within the vicinity of the generator but which require a diversions from that roadway to another roadway to gain access to the site. These roadways could include streets or freeways adjacent to the generator, but without access to the generator.

In calculating the emissions associated with a proposed project, the distinction between these three categories of trips is important. Pass-by and diverted linked trips associated with a proposed project generate substantially lower levels of net emissions than a primary trip.

For air quality impact analysis, the major difference between a pass-by trip and a diverted linked trip is the added vehicle miles traveled associated with the diverted linked trip. Pass-by trips, by definition, do not require a diversion from the original trip route. Conversely, diverted linked trips do involve diversion from the original trip route. A major difficulty in estimating the additional travel associated with a diverted linked trip is that the amount of additional travel is sensitive to local site factors. In particular, the distance from the project site to major arterials or freeways strongly influences the amount of additional travel.

Pass-by and diverted linked trips are most important for retail commercial land uses. As an example of how important these trips are, the February 1995 update to ITE's Trip Generation, 5th Edition, notes that an average of 87% of trips made to gasoline stations in the p.m. peak hour are pass-by and diverted linked trips. Not accounting for pass-by and diverted linked trips substantially overstates the amount of indirect source emissions associated with a proposed gasoline station.

URBEMIS7G has an option that allows the user to account for pass-by and diverted linked trips. The primary data sources for appropriate pass-by and diverted linked trip adjustments are ITE's Trip Generation, 5th Edition, and the February 1995 update (ITE 1991; ITE 1995). The San Diego Association of Governments (SANDAG) has also produced a document that includes estimates of pass-by and diverted linked trips for specific land uses (SANDAG 1990). These three documents present pass-by and diverted linked trip values as a percentage of total trips for several land use categories. One distinction between the ITE versus SANDAG estimates are that for pass-by trips, SANDAG assumes that any diversion requiring 1 additional mile or less is a pass-by trip. In contrast, ITE assumes that any diversion off of the intended travel route is a diverted linked trip.

Table C-1 shows estimates of pass-by and diverted linked trip percentages using data contained in ITE's Trip Generation, 5th Edition, the February 1995 update to the 5th edition, and the SANDAG report (ITE 1991, ITE 1995; SANDAG 1990). The ITE and SANDAG trip generation data primarily describe peak-hour versus average daily conditions. Jones & Stokes Associates has developed average daily percentages of primary trips, diverted-linked trips and pass-by trips associated with each land use for the URBEMIS7G model.

When the pass-by trip correction algorithm is selected by the user, URBEMIS7G adjusts trip end emissions (i.e., cold start, hot start, and hot soak) associated with pass-by and diverted linked trips

For traffic impact analyses, pass-by trips are generally eliminated from consideration; they have no net effect on traffic volumes. Similarly, diverted linked trips may have a minimal effect on traffic volumes. Conversely, pass-by and diverted linked trips may have a substantial effect on air quality, and this effect may increase in the future as trip end emissions become a larger portion of total vehicle trip emissions. A pass-by or diverted linked trip associated with a shopping center is a good example of how these trips can affect air quality. Such a trip would have little or no net effect on traffic volumes. However, if the shopper stays at the shopping center for 1 hour, a substantial portion of a hot soak episode would occur and, for a catalytic converter-equipped vehicle, the trip leaving the shopping center would begin in a cold-start mode.

URBEMIS7G estimates trip end emissions associated with pass-by and diverted linked trips and additional travel associated with diverted linked trips. Jones & Stokes Associates has modified URBEMIS7G so that it makes separate emission estimates for primary trips, pass-by trips, and diverted-linked trips.

For primary trips, the emission estimating procedure do not change except that the trip generation rate for each land use would be multiplied by that land use’s primary trip percentage shown in Table C-1.

For pass-by trips, the trip generation rate for each land use are multiplied by that land use’s pass-by trip percentage shown in Table C-1. In addition, the trip length for each trip type (e.g., home-work, home-shop) is set to 0.01 miles. The change in trip length reflects the pass-by trip definition in that these trips result in virtually no additional travel. However, emissions associated with pass-by trips still occur. Consequently, the hot and cold start percentages are increased by 10 percent to reflect additional emissions from these operating modes.

For diverted-linked trips, the trip generation rate for each land use is multiplied by that land use’s diverted-linked trip percentage shown in Table C-1. The trip length is also adjusted downward to equal 25 percent of the primary trip length for each trip type. By doing so, it accounts for the additional travel associated with diverted-linked trips. Also, the hot and cold start percentages for each trip type are increased by 10 percent to reflect additional emissions from these operating modes.

Method for Calculating Default Trip Lengths from Travel Survey Data

Trip lengths are one of the most important data elements used in calculating project emissions. Air districts or other agencies responsible environmental review should ensure that default trip length values used in their area have a sound basis. Unfortunately, the data most readily available from regional travel models for this purpose is typically formatted differently than is used in URBEMIS. This section provides a method for converting available data for use as URBEMIS7G defaults.

One source of data is the Caltrans Statewide Travel Survey. The most recent version was published in 1991. The data is stratified by trip purpose. The trip categories are home to work (H-W), home to shop (H-S), home to other (H-O), other to work (O-W), and other to other (O-O). The survey provides trip lengths for only H-W and total trips. More detailed breakdowns may be available from the Regional Transportation Planning Agency in your area. The survey

Table C-1. Primary, Pass-by, and Diverted Linked Trip Percentages

	Recommended Percentages:			**Available Data:**		
	Primary Trip (%)	**Diverted-Linked Trip (%)**	**Pass-By Trip (%)**	**Source**	**Trip Categories (Primary/ Diverted/ Pass-By)**	**Time Period**

Land Uses						
Single Family Housing	90	10	0	San Diego(1)	86/11/3	Daily
Apartment, Low Rise	90	10	0	San Diego(1)	86/11/3	Daily
Apartment, High Rise	90	10	0	San Diego(1)	86/11/3	Daily
Condominium/Townhouse, General	90	10	0	San Diego(1)	86/11/3	Daily
Condominium/Townhouse, High Rise	90	10	0	San Diego(1)	86/11/3	Daily
Mobil Home Park	90	10	0	San Diego(1)	86/11/3	Daily
Retirement Community	90	10	0	San Diego(1)	86/11/3	Daily
Elementary School	60	40	0	San Diego(1)	57/25/10	Daily
High School	75	25	0	San Diego(1)	75/19/6	Daily
Church	75	25	0	San Diego(1)	64/25/11	Daily
Racquet Club	50	50	0	--	N/A	--
Racquetball/Health Club	50	50	0	--	N/A	--
Day-Care Center	25	75	0	San Diego(1)	28/58/14	Daily
Quality Restaurant	60	30	10	--	N/A	--
High-Turnover (sit-down) Restaurant	30	40	30	ITE Update	28/32/40	P.M. Peak
Fast-Food Restaurant without Drive-Through Window	30	35	35	--	N/A	--
Hotel	70	30	0	San Diego(1)	58/38/4	Daily
Motel	70	30	0	San Diego(1)	58/38/4	Daily
Free-Standing Discount Store	45	45	10	San Diego(1)	45/40/15	Daily
Regional Shopping Ctr. >570,000 sq. ft. gross leasable area (GLA)	55	25	20	ITE	Varies	Daily
Regional Shopping Ctr. <570,000 sq. ft. gross leasable area (GLA)	50	25	25	San Diego(1)	47/31/22	Daily
Convenience Market (16 hr.)	25	30	45	ITE Update	16/18/66 (2)	P.M. Peak
Convenience Market (24 hr.)	25	30	45	ITE Update	16/18/66 (2)	P.M. Peak
Bank (Walk-In Only)	35	45	20	San Diego(1)	35/42/23	Daily
Bank (with Drive-Through)	35	45	20	San Diego(1)	35/42/23	Daily
General Office Building	80	20	0	San Diego(1)	77/19/4	Daily
Office Park	80	20	0	--	N/A	--
Government Office Building	70	30	0	--	N/A	--
Government (Civic Center)	70	30	0	San Diego(1)	50/34/16	Daily
Medical Office Building	60	40	0	San Diego(1)	60/30/10	Daily
Hospital	75	25	0	San Diego(1)	73/25/2	Daily
General Light Industry	90	10	0	--	N/A	--
General Heavy Industry	95	5	0	San Diego(1)	92/5/3	Daily
Industrial Park	90	10	0	--	N/A	--
Manufacturing	90	10	0	--	N/A	--
Additional Land Uses:						
Junior High School	65	35	0	San Diego(1)	63/25/12	Daily
Junior College (2 Years)	95	5	0	San Diego(1)	92/7/1	Daily
University/College (4 Years)	95	5	0	San Diego(1)	91/9/0	Daily
Library	50	50	0	San Diego(1)	44/44/12	Daily
Fast-Food Restaurant with Drive-Through Window	30	30	40	ITE Update	29/24/47	P.M. PEAK
Free-Standing Discount Superstore (1)	55	40	5	San Diego(1)	45/40/15	Daily
Discount Club (2)	55	40	5	San Diego(1)	45/40/15	Daily
Convenience Market with Gasoline Pumps	20	30	50	ITE Update	16/18/66	P.M. PEAK
Gasoline /Service Station	20	40	40	ITE Update	21/21/58	P.M. PEAK
Neighborhood Park (undeveloped)	70	30	0	San Diego(1)	66/28/6	Daily

Table C-1 (continued)

Notes:
(1) Trip category percentage ratios are from local household surveys and often cannot be applied to very specific land uses. It should be noted that this source defines pass-by trips as trips that are either undiverted or are diverted by less than a mile, while in URBEMIS 5 pass-by trips are defined only as undiverted trips, and any diverted trip is considered to be a diverted-linked trip.
(2) The data is for a convenience market with gas pumps.
N/A = Data Not Available

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and most RTPA models provide trip lengths in terms of minutes. The average speed is used to convert minutes to miles.

The H-W, H-S, and H-O trip lengths can be used directly in URBEMIS. However, for non-home based trips, URBEMIS uses work (W) and non-work (N-W) trips when analyzing all non-residential projects (commercial, industrial, institutional, etc). To produce work-related trip lengths for non-residential projects analyzed in URBEMIS, a composite work trip length is calculated that is a composite of H-W and O-W trip lengths. For URBEMIS, non-work trips are a composite of H-S, H-O, and O-O trip lengths. Both are based on the relative occurrence of the individual trip types.

The following table illustrates this concept using Southern California data as an example:

Travel Survey Trip Types:	**H-W**	**H-S**	**H-O**	**O-W**	**O-O**	**Total**
Percent trip type:	20%	9%	43%	11%	17%	100%
Trip length in minutes:	19.63	7.91	9.58	15.06	8.96	
Trip length in miles:	11.5	4.87	6.02	9.07	5.66	

URBEMIS non-residential Work trip lengths = composite of H-W + O-W
URBEMIS non-residential Non-Work trip lengths = composite of H-S + H-O + O-O

Work Trip Length Formula:

(%H-W / (%H-W + %O-W) x H-W TRIP LENGTH) +

(%O-W / (%H-W + %O-W) x O-W TRIP LENGTH)

Non-Work Trip Length Formula:

(%H-S / (%H-S + %H-O + %O-O) x H-S TRIP LENGTH) +

(%H-O / (%H-S + %H-O + %O-O) x H-O TRIP LENGTH) +

(%O-O / (%H-S + %H-O + %O-O) x O-O TRIP LENGTH)

Example Calculation Using South Coast Data:

Commute Trip (W)

(20%/(20%+11%) X 11.5 mi.)+ (11%/(20%+11%) X 9.07 mi.) = 10.6 mile W trip

Non-Work Trip (N-W)

(9%/(9%+43%+17%) X 4.87 mi.) + (43%/(9%+43%+17%) X 6.02 mi.) +
(17%/(9%+43%+17%) X 5.66 mi.) = 5.78 mile N-W trip

Default Values for Emission Calculations

Diurnal Soak Hours per Day: 7.1

Resting Loss Hours per Day: 12.9

Vehicles per Household: 1.8

Appendix C References

Institute of Transportation Engineers. 1991. Trip generation. 5th edition, Washington, DC.

Institute of Transportation Engineers. 1995. Trip generation February 1995 update to the 5th edition. Washington, DC.

California Air Resources Board. 1997. Emission inventory procedural manual volume III methods for assessing area source emissions. Sacramento, CA. 1997.

San Diego Association of Governments. 1990. San Diego traffic generators. California Department of Transportation, District 11. San Diego, CA.

U.S. Environmental Protection Agency. 1995. AIR CHIEF CD-ROM, Version 4.0. Research Triangle Park, NC.

Appendix D. "Mobile Source Mitigation Component" Documentation

“Mobile Source Mitigation Component”

Background

The purpose of this appendix is to document the basis of the emission reduction quantification system used in the URBEMIS 7G Mobile Source Mitigation Component (Component). It also describes how the various parts of the Component work together to determine project level emission reductions. Section III. 8.2 explains how a program user would navigate through various selection screens and briefly describes information needed for setting each environmental factor in the Component.

The Component is a tool for quantifying emission reductions achievable by development projects under a wide range of conditions. It uses a two step process. The first step creates “environmental factors” to take into account the effects of existing and planned development and transportation infrastructure near the project site on trip generation at the project site. The second step allows selection of specific measures that will result in emission reductions for projects. The Component then applies the factors set in step one to the mitigation measures selected in step 2 and arrives at a percent reduction in trips and reductions in vehicle miles traveled. The URBEMIS program then translates these trip and VMT reductions into emission reductions.

Research related to factors affecting vehicle travel found that neighborhood level trip generation and vehicle miles traveled vary by as much as fifty percent in California cities (JHK and Associates, 1995a). The primary factors cited for the variation were density, mix of uses, proximity of uses, transportation systems, and access. Areas with low trip generation and VMT levels and the greatest transit use and pedestrian activity also had the highest densities, a wide variety of uses within walking distance, safe and comfortable pedestrian access, paid parking requirements, and a high level of transit service. Areas with the highest trip generation and VMT levels had low development densities, strict separation of land uses, poor pedestrian access between land uses, abundant free parking, and poor transit service. Use of bicycles varied by orders of magnitude in different cities but the differences were due primarily to access and safety considerations. The Component uses this information to determine a variable credit for applying mitigation measures to development projects.

The Component estimates trip reduction relative to Institute of Transportation Engineers (ITE) Trip Generation rates for a particular land use. ITE trip generation data are primarily obtained from counts of the number of motor vehicles entering and leaving driveways at a project site. A number of studies of similar land uses are conducted and the results are statistically manipulated to obtain the trip generation rate. People walking, bicycling, and using transit for their trips are not counted. This is significant because as was described earlier, a project’s setting can dramatically affect the share of trips absorbed by transit, bicycling, and walking, and the overall trip generation rate. The Component attempts to use a project’s environmental setting and mitigation measures to estimate the percentage of trips that will be diverted to these alternative modes of transportation compared to the averages used by ITE.

BASIS AND DESCRIPTION OF COMPONENT ENVIRONMENTAL FACTORS

Introduction

The Component contains a series of screens requiring the user to set environment factors in three categories: pedestrian, transit, and bicycle. These factors are used later to determine the effectiveness of infrastructure and design based mitigation measures. The environmental factors provide a sliding scale that allows a project's trip generation to reflect levels achieved at real world locations having similar conditions.

Pedestrian Environment

The pedestrian environment factor (PEF) is set by grading a project in each of seven factors. Each factor allows the user to select one of three possible scores or to skip the factor and assign a score of zero. The factors are weighted by setting the maximum possible score at between 2 for the least important factors and 5 for the most important factor. The weighting is based on review of the literature on walking and pedestrian enhancement. It uses concepts developed by Holtzclaw for the Bay Area (Holtzclaw, 1994) and work done for the LUTRAQ project in Portland, Oregon (1000 Friends, 1996). The seven different factors used in determining the PEF are listed in Table D-1.

TABLE D-1
Pedestrian Environment Point Ranges

Factor	Score Range in Points
Mixture of Uses To Attract Pedestrians Within Walking Distance These factor is not included here in the model.	0-5
Sidewalks and Pedestrian Paths	0-3
Pedestrian Circulation Provides Direct Access	0-3
Street Trees Provide Shade Canopy	0-2
Street System Designed to Enhance Pedestrian Safety	0-2
Pedestrian Routes Provide Safety from Crime	0-2
Walking Routes to Important Destinations Provide Visual Interest	0-2
TOTAL POINTS POSSIBLE	19

Program users score the project being analyzed based on the environment within one mile of the project site. A one mile walking distance is based on maximum walking trip lengths described in the National Bicycling and Walking Study (Case Study 3). For small projects, the analysis would be based primarily on land beyond the project boundary. For large self-contained projects, the analysis would be based mostly on the internal design of the development. Since every project site is different, user judgement is required for determining the analysis boundary.

The heaviest weighted feature is the mixture of uses within walking distance. Without destinations to walk to, all other features only enhance recreational walking. Distance comes into play again on pedestrian circulation providing direct access. With most people being unwilling to walk more than 1/4 mile (Cervero, 1994) anything that creates barriers to pedestrian access and makes trip distances longer will discourage walking. Several features are listed that enhance pedestrians' comfort and safety during the walking trip. When routes are safe and attractive, pedestrians will walk longer distances, thus widening the range of potential trip destinations for a greater number of people.

The PEF is calculated by adding the scores for each factor and dividing the total by the maximum possible score. For example, a project that scores 12 of the possible 19 points would earn a PEF of 12/19 = .63. This is accomplished as an internal program calculation.

Transit Environment

The transit environment selection screen uses a 0-100 point scale for rating system effectiveness. The end points of the scale are anchored with dial-a-ride service at 0 and urban heavy rail service within 1/2 mile (BART) at 100. Intermediate data points between these two types of service were determined using two 1994 studies by Cervero (*Transit-based Housing in California: Evidence on Ridership Impacts* and *Rail-Oriented Office Development in California: How Successful?*) The studies provide mode share data for heavy rail, commuter rail, and light rail systems in California. The studies also provide mode shares for development near transit and on a regional basis.

Bus service levels were based on mode shares achieved by urban and suburban bus services in California. More suburban cities with relatively poor fixed route bus service have about a one percent transit mode share (U.S. Census, 1990).

The transit environment uses a distance decay factor to determine the relative effectiveness of light rail at 1/4 and 1/2 mile. The highest mode shares were achieved by developments within 1/4 mile of the light rail station. Using a distance decay factor of 0.85 percent per 100 feet (Cervero 1994), an additional 1,320 feet (1/4 mile) would result in an 11 percent reduction in effectiveness.

No credit is given for transit beyond 1/2 mile for rail and 1/4 mile for bus service. These distances are based on limits most people are willing to walk (Cervero, 1994). Beyond 1/2 mile from rail, most people drive or use bus transit to get to the train station. Except in very urbanized areas, the number of people using a bus to get to rail transit is quite small. Because of cold start and hot soak emissions, the air quality benefit of people driving to rail is limited to the vehicle miles traveled (VMT) reduced by not driving the full distance. Its effects are more akin to those of a park and ride lot. Dial-a-ride services are considered 0 because they provide transportation for trips that would in most cases not have been made or would have been made by carpooling.

To account for the effect of the pedestrian environment on people’s ability to walk to the transit stop or station, the Component uses a pedestrian accessibility adjustment (PAA). The PAA uses the pedestrian environmental factor (PEF) obtained in the previous screen. If the pedestrian environment is poor, fewer people will be willing to walk to the station, even if close. If the pedestrian environment is good, people will be encouraged to walk to the station or transit stop. The PAA is based on an assumption that transit use can be influenced by up to 10 percent by the pedestrian environment. This number is somewhat modest to reflect Cervero’s 1994 finding that proximity and parking availability at the destination dominate other factors affecting transit.

After the level of transit service and the pedestrian environment have been set, the program calculates a transit environment factor (TEF) between 0 and 1. The TEF is based on the score achieved divided by the total possible score. For example, light rail within 1/2 mile is worth 40 points. If the project had an outstanding pedestrian environment factor of 1, the pedestrian adjustment is (10 % * 40 x 1 = 4 points) The total score is then 44 out of a possible 110 and 44/110 = 0.4. A factor of 0.4 means that a project in this environment may achieve 40 percent of the maximum possible trip reduction for transit.

Bicycle Environment

The bicycle environment factor (BEF) selection screens list 6 different factors affecting how much people will bicycle for purposes other than recreation. Bicycle distance for all measures is set at 5 miles based on the maximum cycling distance described in *The National Bicycling and Walking Study Case Study 4* (U.S. Department of Transportation, Federal Highway Administration, 1993). As with the PEF, each feature's points are weighted, in acknowledgment that some features are more important than others. The 6 features and their scoring ranges are listed on Table D-2. The BEF is calculated in the same manner as the PEF.

The bicycle environment factor (BEF) utilizes other information from *The National Bicycling and Walking Study Case Study 4* to determine and weight factors affecting bicycle use. The weighted factors are based on surveys of what bicycle riders believe was preventing them from using a bicycle for transportation. The primary factors are directly or indirectly related to safety. The more safe and secure bicyclists feel as they ride, the more likely they are to use bicycles for transportation. The second most important consideration is distance. Since most bicycle trips are less than 5 miles in length and the average is around 2.5 miles, without a good mixture of uses within bicycling distance on safe routes, few people will choose to use a bicycle. Schools, particularly colleges and universities, are major contributors to bicycle mode shares. University towns like Davis and Palo Alto have very high bicycling rates. The final factor is secure bike parking at the destination.

TABLE D-2
Bicycle Environment Point Ranges

Factor	Score Range in Points
Area Served by Interconnected Bikeways	0-5
Bike Routes Provide Wide Paved Shoulders and Few Curb Cuts	0-3
Speed Limits of 30 MPH or Less on Streets with Bike Routes	0-2
Schools with Safe Routes	0-5
Mixture of Uses to Attract Bicyclists within Easy Cycling Distance	0-3
Community Has Bike Parking Ordinance	0-2
TOTAL POINTS POSSIBLE	20

BASIS and DESCRIPTION of the MITIGATION MEASURE SELECTION and QUANTIFICATION SYSTEM

Introduction

In the second step of the process, the user selects measures from a series of screens: transit, pedestrian and bicycle infrastructure, operational measures, and vehicle miles traveled reduction measures. Separate screens are provided for residential and commercial measures with the option available for viewing either or both sets of measures. Separate commercial and residential screens allow the program to credit measures to the appropriate trip types. The three sets of infrastructure based measure screens (transit, pedestrian, and bicycle) have a section referred to as "project description measures." These measures allow trip reduction percentages to be credited to a project even when a project applicant provides no formal mitigation measures. It allows better prediction of trip generation rates without applying unrealistically high benefits to individual measures. More discussion of project description measures is provided later.

Program users select measures appropriate for their project and the screen displays the maximum percent trip reduction possible. These numbers are later reduced by the environment factors determined in step 1 to ensure that the trip reduction credited is as accurate as possible.

The emission reduction percentages for individual infrastructure measures and operational measures are taken from trip reduction estimates from CEQA guidelines used by several California air pollution control districts, including South Coast, Sacramento, Bay Area and Monterey Bay.

The program allows the user to add measures not listed on the measure screens. The amount of credit allowed, however, is limited to a maximum amount allowed for each type of measure (transit, bicycling, etc.). So, for example, if an applicant identifies a bicycling measure not listed on the screen, the total amount of credit cannot exceed 9 percent. When more than 9 percent is listed, the program displays an error message. This is to prevent the program user from showing reductions beyond what is feasible to achieve.

Project Description Measures

Each infrastructure measure selection screen contains one to three "project description measures." The first measure in each case is a credit for pedestrian, transit, or bicycle environment. The concept can be explained with an example. An apartment complex is proposed for a site 1/4 mile from an existing light rail station. Future tenants of the complex are much more likely to use light rail than the average person yet the developer has no need or ability to provide transit supporting infrastructure since it already exists. Therefore, a mechanism was needed to recognize the trip reduction benefit of the decision to develop at that particular site. Thus, the credits for environment were devised. The amount of the credit was set at a level that would allow a project with the best possible environment and all feasible infrastructure measures to achieve mode shares found in the literature for similar projects. Since most projects fall well below the best, the environment factor is applied to the total to provide a comparison of a particular site with the best. The credit for environment is not a user selection. As long as the environmental factors are greater than zero, some credit is given to each project.

The second types of project description measures are user selected. These are different for each infrastructure measure screen. The transit screen includes a credit for project density meeting transit level of service requirements. The pedestrian screens include a credit for residential and commercial mixed use projects and for commercial projects with high floor area ratios (FAR). These credits are used in the system devised by JHK & Associates for the Oregon Department of Environmental Quality (JHK & Associates, 1995b). The bicycle screen contains no additional credits.

Transit Mitigation

For transit, the maximum achievable reduction has been set at 25 percent, based on the Cervero 1994 rail studies. This reduction is based on a 25 percent transit mode share in urban residential developments within walking distance of a BART station. Most of this potential reduction is due entirely to the developer's decision to locate near an existing or planned transit system. For this reason 15 percent of the possible 25 percent reduction is given as a credit for existing or planned community transit service. This number may seem high, but it will be reduced by the TEF in the next step.

The second measure, included as part of the project description is density. If project density is greater than or equal to the density standards needed to support the type of transit serving the site, 6 percentage points are awarded. Projects not meeting density standards degrade transit service and so are not awarded any points. Density standards are based on numbers developed by the State of Florida (Table D-3) and by Pushkarev and Zupan (Table D-4).

TABLE D-3
Transit Related Density Standards

Mode of Transit	Level of Service	Minimum Necessary Residential Density (Dwelling Units Per Acre)	Other Characteristics
Dial-A-Bus	Many Origins/Destinations	6	Only if labor costs are not twice those of taxis.
Dial-A-Bus	Fixed Destination or Subscription Service	3.5 to 5	Lower figure if labor costs are twice those of taxis; higher if thrice.
Local Bus	Minimum 1/2 Mile Route Spacing, 20 Buses Per Day	4	Average varies as a function of downtown size and distance from residential area to downtown.
Local Bus	Intermediate - 1/2 Mile Route Spacing, 20 Buses Per Day	7	
Local Bus	Frequent - 1/2 Mile Route Spacing, 120 Buses Per Day	15	
Express Bus - Reached on Foot	Five Buses During Two-Hour Peak	15 - Average Density Over Two Mile Area	From 10 to 15 miles away to largest downtowns.
Express Bus Reached by Auto	Five to Ten Buses During Two-Hour Peak	3 - Average Density over 20 Square Miles	From 10 to 20 miles away to downtowns large than 20 million square feet of non-residential floor space.
Light Rail	Five-Minute Headways or Better During Peak	9 - Average Density for Corridor of 25 to 100 Square Miles	To downtowns of 20 to 50 million square feet of non-residential floor space.
Rapid Transit	Five-Minute Headways or Better During Peak	12 - Average Density for Corridor of 100 to 150 Square	To downtowns larger than 50 million square feet of non-residential floor space.

		Miles	
Commuter Rail	20 Trains Per Day	1-2	To CBDs with rail.

Source: *Florida Statewide Transit System Plan, Phase III, Development of State Transit Standards*, October 1988.

TABLE D-4
Minimum Residential Densities to Support
Different Levels of Transit Service

Mode of Transit Service	Frequency	Minimum Density DU/Res Acre
Frequent Bus Service	Every 10 minutes, 20 hours per day - 120 buses/day 1/2 mile spacing over area	15
Rapid Transit (Heavy Rail)		12
Light Rail (Street car, radial corridors)		9
Intermediate Bus Service	1/2 hourly, 20 hours per day - 40 buses/day	7
Minimal Bus Service	½ hourly, 10 hours per day or hourly, 20 buses per day	4
Commuter Rail on Existing Track		2

Source: JHK & Associates, 1995a.

The remaining 4 possible percentage points are awarded for infrastructure measures to be provided by the developer. The measures are assigned reductions ranging from 0.5 to 2 percent based on their relative contributions to making transit use more convenient and comfortable. These percentages are taken from trip reduction estimates in CEQA guidelines used by several California air pollution control districts.

If we return to our project served by light rail with the excellent pedestrian environment, and the developer provides the density and all infrastructure measures, then the actual percent trip reduction would equal 25 percent x 0.4 TEF = 10 percent reduction. We would expect 10 percent of work trips to be captured by the light rail system. This number is consistent with Cervero's findings for mode shares for residential development 1/2 mile from light rail.

Pedestrian Mitigation

Pedestrian mitigation measures are presented on 2 screens: residential projects and non-residential projects. The maximum achievable reductions have been set at 9 percent for residential projects and non-residential projects. The maximum reductions are derived mainly from an analysis of Bay Area travel surveys (Fehr and Peers, 1992). This study provides mode shares for traditional versus suburban neighborhoods. Non-home-based trips in traditional neighborhoods achieve up to a 9 percent increase in pedestrian mode share over standard suburban development (see Table D-5). Oregon's LUTRAQ study (1000 Friends, 1996) contains pedestrian mode share information that confirms the Fehr and Peers information (see Table D-6). Walk/bike mode share in TODs for "home-based other trips" (HBO) is 12.8 percent compared to 3.3 percent for the no build alternative. Total home-base non-work (HB N-W) is 20.7 percent for TODs compared to 6 percent for the no build alternative. Other trip types show similar reductions. The bottom level for pedestrian travel approaches zero in very low-density suburban or rural settings. Some projects may have no destinations within walking distance.

TABLE D-5
Trip Differences Between Traditional and Suburban Bay Area Neighborhoods for Walking Trips

Trips	Traditional Neighborhoods (percent)	Suburban Neighborhoods (percent)	Differences (percent)
Home Based Work	4	3	1
Home Based Non Work	14	10	4
Work Based Other	15	8	7
Non Home Based Trips	17	8	9
All Trips Combined	12	8	4

Source: Based on Fehr and Peers. *Metropolitan Transportation Commission Bay Area Trip Rate Survey Analysis, Oakland, CA.* MTC, 1992.

TABLE D-6
Walk/Bike Mode Choice from LUTRAQ
(by percentage of trip type)

Trip Type	No Build Alternative	LUTRAQ TOD Only (adj.)	Difference
Home Based Work	2.8	6.1	3.3
Home Based Non-Work	6	20.7	14.7
Total Home Based	5.1	17.2	12.1
Non-Home Based Work	.4	13.1	12.7
Non-Home Based Non-Work	.3	10.2	9.9
Total Non-Home Based	.3	11.4	11.1
Total All Trips	3.8	15.6	11.8

Source: 1000 Friends of Oregon, 1996.

Work-based customer trips achieve very high pedestrian mode shares in high-density downtown settings compared to suburban settings. ARB's shopping center study (JHK & Associates, 1993) found that regional shopping centers in two California low-density suburban settings had pedestrian mode shares of 0.7 and 1.6 percent (See Table D-7). A shopping center in a high-density suburban setting had a 21.7 percent pedestrian share and another in a high-density urban setting had a 28.9 percent share.

Although the pedestrian mitigation screens allow a maximum trip reduction of 9 percent, operational measure screens account for other trips reduced. For example, an additional reduction of up to 10 percent may be added on the operational measures screen if the employees and customers must pay for parking. This parking credit is included in the operational measures section because it increases all alternative mode use, not just walking. Two percent of the possible 9 percent is given as a credit for the surrounding pedestrian environment, 1 percent is awarded if the project is a commercially oriented mixed use project, and an additional 1 percent if its floor area ratio is 0.75 or greater.

TABLE D-7
Walking Mode Shares in California Regional Shopping Centers
(Percent)

Suburban Low-Density 1	Suburban Low-Density 2	Suburban Medium-Density	Suburban High-Density	Urban High-Density
0.7	1.6	19.3	21.7	28.9

Source: JHK & Associates for California Air Resources Board. *Analysis of Indirect Source Activity at Regional Shopping Centers, Final Report A132-094*. November 1993.

For residential projects, 2 percent of the possible 9 percent, is allotted as a credit for the surrounding pedestrian environment and an additional 3 percent is awarded if the project is a residentially oriented mixed use project. The remaining 4 possible percentage points for residential projects and 5 points for non-residential projects are awarded for infrastructure measures to be provided by the developer. The measures are assigned reductions ranging from 0.25 to 1 percent based on their relative contributions to making pedestrian travel more safe, comfortable, and convenient. These numbers are generally based on percentages used in the air district CEQA guidelines referred to earlier.

Bicycle Mitigation

Bicycle mitigation measures are presented on 2 screens: residential projects and non-residential projects. The range in trip reduction effectiveness for bicycles is very broad. In Davis, bicycling captures about 25 percent of work trips. In Palo Alto, about 10 percent of all trips are accomplished by bicycle (U.S. Department of Transportation, Federal Highway Administration, 1993). At the bottom of the scale, many cities achieve less than 1 percent bicycle mode share. For both residential and non-residential projects, the maximum achievable mitigation credit was set at 9 percent to reflect a level of improvement from the typical 1 percent to the outstanding 10 percent achieved by Palo Alto. Davis was not used as the maximum because it would skew the percent trip reductions excessively high. Although possible to recreate the environment and bicycle infrastructure that led to Davis' high bicycle mode share, the attitude of local residents toward bicycling would take many years to cultivate.

The remaining 2 possible percentage points for residential projects and 4 points for non-residential projects are awarded for infrastructure measures to be provided by the developer. The measures are assigned reductions ranging from 1 to 2 percent based on their relative contributions to making bicycle travel safer, and more comfortable, and convenient.

Operational Measures

Operational mitigation measures are divided among three screens based on the type of trip impacted. The first set of measures apply to commute trips. These include some measures that may be provided by an employer and other measures that may be obtained from other service providers or that take advantage of the existing built environment. Examples of the former are a compressed work schedule and preferential carpool parking. Examples of the latter are an office built in an area with limited, paid parking not owned or leased by the employer. The second set of measures apply to employee shopping trips and errands. Some measures have the employer provide services at the employment site that employees would normally have to use a car to obtain. The second strategy is to provide alternative transportation in the form of a shuttle to lunch and shopping areas out of walking range of the employment site. The third set of measures apply to customer and client trips. The only measure listed in this case is paid parking.

The percentage reductions used for the operational measures were taken from CEQA Guidelines used by several California air pollution control districts. Use of compressed work schedules provides up to a 40 percent reduction for businesses having 100 percent of their employees on a 3/36 work schedule (3 days/week, 12 hours/day). Charging for parking is the next most effective measure, allowing up to a 10 percent reduction in areas with high daily parking charges.

Measures Reducing Vehicle Miles Traveled (VMT)

The final set of screens include measures that usually do not reduce vehicle trips, but do reduce VMT. The two measures included are park and ride lots and satellite telecommuting centers. These could either be provided by or in proximity to a residential development or by a commercial development.

The input screen for these measures require the user to provide the number of people that can use the facilities. For, example, on any given day a park and ride lot with 100 spaces can be used by 100 drivers. The number of spaces is then multiplied by 89 percent to account for the average portion of the trip driven by private vehicle to the park and ride lot or to the telecommuting center (Monterey Bay UAPCD, 1995). Currently, the program assumes 100 percent use of the facility. This may be reduced based on local conditions. For telecommuting measures, the program assumes that facilities will be used by employees two days per week. If a business allows telecommuters greater or lesser use, the percent employees participating can be adjusted to reflect the actual trip reduction benefit. For example, if 10 percent of employees are telecommuting 5 days per week, the percent employees should be adjusted from 10 to 25 percent to compensate for the higher days per week. If 10 percent of all employees are telecommuting only 1 day per week, the percent should be adjusted to 5 percent.

Another potential measure not currently listed on the VMT measure screen is rail station parking. Developments in communities served by rail, but farther than one half mile from a rail station will achieve reduction in VMT not accounted for in the transit screens discussed earlier. Using BART as an example, 5.5 percent of station area residents drove to the station compared to 80 percent of all suburban Bay Area residents (Cervero, 1994). Using citywide work trip mode splits for BART of 4.4 percent for Hayward, and the 80 percent drive to station statistic, VMT reduction would apply to 4.4% x 80% = 3.5% for suburban communities served by BART. Therefore, a development generating 100 work trips in a community with a BART station would reduce VMT by 3.5 trips x average trip length for work trips (10 mi.) x trip length driven to the station (5 miles) divided by the total home to work trip length (10 mi.) = 35 miles.

The calculation methodology is as follows:

$$\frac{RTMD \times \%DTS \times AWTL \times H\text{-}SATL}{H\text{-}WATL \times \#PWT} = MS$$

RTMD = Citywide mode share for rail transit
%DTS = percent expected to drive to the station
AWTL = average work trip length
H-S ATL = average trip length from home to station

H-WATL = average trip length home to work
#PWT = number of work trips for the particular project
MS = miles saved by rail transit system.

The number of work trips can be obtained from URBEMIS. For example, for a residential development in Sacramento, 27.8 percent of trips are home to work trips. Each residence generates

9.6 trips per day, so .278 x 9.6 = 2.7 work trips per residence. A 100 unit residential development would generate 270 work trips.

If data are available for all trip types, they may be used to calculate VMT reductions from all trips instead of just the commute trip. The example used above is based on work trips because rail mode split data were located for only work trips.

CORRECTION FACTORS

Trip Type Correction Factors

URBEMIS 7G calculates emissions based on six trip types. Home based trip types are home to work (H-W), home to shop (H-S), home to other (H-O). Trips for commercial land uses include work trips (W), non-work employee trips (N-W-Emp), and non-work customer trips (N-W Cust). A number of studies show that certain trip types are more likely to be captured by one mode rather than another. The calculation procedure uses a correction factor to account for these differences. Trip type correction factors are provided in Table D-8.

TABLE D-8
Trip Type Correction Factors

	H-W	H-S	H-O	W	N-W Emp	N-W Cust
Transit	1.0	.22	.27	1.0	.02	1.0
Pedestrian	.11	.44	.44	.11	1.0	1.0
Bicycle	1.0	1.0	1.0	1.0	1.0	1.0

Source: Cervero, 1994a, 1994b and JHK & Associates, 1993.

The commute trip is most likely to be made using transit while shopping trips are the least likely to be made by transit. To determine the correction factor, the best trip type was set equal to one (1). To determine the correction factors for the other trip types their mode shares were divided by the mode share of the highest trip type. For example, if the home to work mode share is 19 percent and the home to shop mode share is 4.1 percent, then the correction factor is 4.1%/19% = 0.22. The correction factor is then multiplied by the trip reduction achieved on the mitigation measure screen to account for the lower effectiveness for this type of trip. For the light rail example previously discussed, work trips achieve a 10 percent reduction, but home to shopping trips achieve reduction of 10 percent x 0.22 = 2.2 percent. The correction factor for transit was derived from Cervero's 1994 survey data for work trips, shopping trips, and other trips for all rail systems in the study.

The correction factor for non-work employee trips was taken from Cervero 1994a. Cervero found that only two percent of people who commuted by rail transit used rail for their midday trips.

Non-work customer trips provide an additional challenge. In an urban setting well served by a regional transit system, 32.5 percent of shoppers arrived by transit to a regional shopping center (JHK and Associates 1993). However, we would expect other commercial developments and service based offices to attract fewer transit riders. Therefore the correction factor was set at 1.0 pending receipt of data on these other types of developments.

Bicycle trip reduction percentages are based on overall trip reduction and not on trip reduction for each trip type. This means that no trip type correction factors are needed. If trip type data are available for bicycling, the program has the capability to use them.

Trip Distance Correction Factors

Trip distance correction factors are needed to account for the fact that bicycle and walking trips replace mostly shorter automobile trips. Trips accomplished by bicycling or walking are reducing less emissions than would be generated using the average vehicle trip lengths used in URBEMIS. This is complicated by cold start and hot soak emissions that are generated by both long and short trips. The longest trips are work trips. In most jurisdictions the work trip now exceeds 10 miles. With the average walking trip at one-half mile, five percent of the running emissions of the average work trip would be reduced plus cold start and hot soak emissions. For home to shopping trips the average trip length is about 5 miles. So, for H-S trips about 1/10 (1/2 mile walk/5 mile drive) of the running emissions would be reduced. For bicycling the average trip length is 2.5 miles; therefore, the correction factors are higher than for walking.

Table D-9 contains the percent of emissions reduced by bicycling and walking trips for two trip distances. The trip distance correction factor is currently based only on ROG.

TABLE D-9
Comparison of Emissions from Trips Replaced with Walking and Bicycling
(Percent)

	ROG	NOx	CO	PM-10
.5 mi. Walking/5 mi. Car Trip	60	23	46	10
.5 mi. Walking/10 mi. Car Trip	42	12	29	5
2.5 mi. Bike/5 mi. Car Trip	78	57	70	50
2.5 mi. Bike/10 mi. Car Trip	54	31	44	25

Note: Comparison of emissions generated by 100 unit residential subdivision generating 1030 trips using all defaults except trip length for a summer run in URBEMIS 7G. Separate runs were done for .5, 2.5, 5.0, and 10 miles.

The trip distance correction factors (see Table D-10) were estimated using an average trip length for automobiles of 5 miles for home to shopping, home to other, and non-work commercial based trips and 10 miles for commute trips. The pedestrian trip length was set at one-half mile and the bicycle trip was set at two and one-half miles based on information from the *National Bicycling and Walking Study*.

TABLE D-10
Trip Distance Correction Factors for ROG

	H-W	H-S	H-O	W	N-W Emp	N-W Cust
Pedestrian	.42	.60	.60	.42	.60	.60
Bicycle	.54	.78	.78	.54	.78	.78

Source: URBEMIS 7G Ver. 1.1

Future upgrades to URBEMIS could provide correction factors for each pollutant based on trip lengths input by the user or the air district. Jurisdictions with short average trip lengths will tend to have higher correction factors since more trips will be within walking and cycling distance. The calculation method would be as follows:

1. Determine average trip lengths for each trip type used by URBEMIS.

2. Determine average trip lengths for bicycling and walking if different than default values.

3. Perform URBEMIS runs for each trip length, setting one trip type equal to 100 percent and others equal to 0 percent.

4. Determine the ratio for each trip type and each pollutant by dividing the total emissions for the walking trip distance by the total emissions for each trip type. For example, emissions using walk trip distance/emission using home to work trip distance.

5. The ratios obtained are the trip length correction factors that will then be applied to the trip reduction percentages for each pollutant.

This may be a programming challenge because the program currently calculates emission reductions based on trip and VMT reductions, not on emission reductions by pollutant.

LIMITATIONS OF THE MITIGATION COMPONENT

The URBEMIS 7G mitigation component is a significant advance over past attempts to quantify the benefits of air quality mitigation measures, however, users should recognize that travel behavior is very complex and difficult to predict. The component relies on the user to determine factors critical to travel behavior that are somewhat subjective. As GIS and electronic traffic monitoring and data collection become a reality in many cities, the ability to identify factors critical to walking, bicycling, and transit use will be enhanced. The URBEMIS 7G mitigation component provides a starting point for using currently available data to demonstrate the benefits of urban design and traditional mitigation measures in reducing air quality impacts.

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Appendix E. Mitigation Measure Emission Reduction Criteria

(to be provided as a separate document)

Appendix F. California Air District Contacts

CALIFORNIA AIR POLLUTION CONTROL DISTRICTS
(URBEMIS Contacts and General Phone Numbers)

AMADOR COUNTY APCD (all of Amador County)
500 Argonaut Lane
Jackson, CA 95642-2310 (209) 223-6406

ANTELOPE VALLEY APCD (NE portion of Los Angeles County)
43301 Division St., Ste. 206
P.O. Box 4409
Lancaster, CA 93539-4409 (805) 723-8070

BAY AREA AQMD (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, W portion of Solano, and S portion of Sonoma counties)
939 Ellis Street
San Francisco, CA 94109-7714
Henry Hilken (415)749-4642

BUTTE COUNTY AQMD (all of Butte County)
2525 Dominic Drive, Suite J
Chico, CA 95928-7184
Gail Williams (530) 891-2882

CALAVERAS COUNTY APCD (all of Calaveras County)
Government Center
891 Mountain Ranch Rd.
San Andreas, CA 95249-9709
(209)754-6521

COLUSA COUNTY APCD (all of Colusa County)
100 Sunrise Blvd. #F
Colusa, CA 95932-3246
Bonnie McCullough (530) 458-5000

EL DORADO COUNTY APCD (all of El Dorado County)
2850 Fairlane Ct., Bldg. C
Placerville, CA 95667-4100
Dennis Otani (530)621-6662

FEATHER RIVER AQMD (all of Sutter and Yuba counties)
938 14th Street
Marysville, CA 95901-4149
Terri Shirhall (530) 634-7659

CALIFORNIA AIR POLLUTION CONTROL DISTRICT CONTACTS
(continued)

GLENN COUNTY APCD (all of Glenn County)
P.O. Box 351 (720 N. Colusa St.)
Willows, CA 95988-0351
Kevin Toganowa (530)934-6500

GREAT BASIN UNIFIED APCD (all of Alpine, Inyo, and Mono counties)
157 Short Street, Suite 6
Bishop, CA 93514-3537
Duane Ono (760)872-8211

IMPERIAL COUNTY APCD (all of Imperial County)
150 South 9th Street
El Centro, CA 92243-2801
Deputy AQCO - Gaspar Torres (760) 339-4606

KERN COUNTY APCD (E portion of Kern County)
2700 "M" Street, Suite 302
Bakersfield, CA 93301-2370 (805)862-5250

LAKE COUNTY AQMD (all of Lake County)
883 Lakeport Blvd.
Lakeport, CA 95453-5405 (707)263-7000

LASSEN COUNTY APCD (all of Lassen County)
175 Russell Avenue
Susanville, CA 96130-4215 (530)251-8110

MARIPOSA COUNTY APCD (all of Mariposa County)
P.O. Box 2039 (5101 Jones St.)
Mariposa, CA 95338-2039 (209)966-5151

MENDOCINO COUNTY AQMD (all of Mendocino County)
306 E. Gobbi St.
Ukiah, CA 95482-5511 (707)463-4354

MODOC COUNTY APCD (all of Modoc County)
202 West 4th Street
Alturas, CA 96101-3915 (530)-233-6419

MOJAVE DESERT AQMD (N portion of San Bernardino County, & E portion of Riverside County)
15428 Civic Drive, Suite 200
Victorville, CA 92392-2383 (760)245-5003

CALIFORNIA AIR POLLUTION CONTROL DISTRICT CONTACTS
(continued)

MONTEREY BAY UNIFIED APCD (all of Monterey, San Benito, Santa Cruz counties)
24580 Silver Cloud Ct.
Monterey, CA 93940-6536
Janet Brennan (408)647-9411

NORTH COAST UNIFIED AQMD
2389 Myrtle Avenue
Eureka, CA 95501 (707)443-3093

NORTHERN SIERRA AQMD (all of Nevada, Plumas, Sierra counties)
200 Litton Dr., Suite 320
P.O. Box 2509
Grass Valley, CA 95945-2509
APCO - Rod Hill (530)274-9360

NORTHERN SONOMA COUNTY APCD (N portion of Sonoma County)
150 Matheson Street
Healdsburg, CA 95448-4908
APCO - Barbara Lee (707)433-5911

PLACER COUNTY APCD (all of Placer County)
DeWitt Center
11464 "B" Ave.
Auburn, CA 95603-2603
Dave Vintze (530)889-7130

SACRAMENTO METRO AQMD (all of Sacramento County)
8411 Jackson Rd.
Sacramento, CA 95826-3904
Phil Stafford/Greg Tholen (916)386-7032

SAN DIEGO COUNTY APCD (all of San Diego County)
9150 Chesapeake Dr.
San Diego, CA 92123-1096
Robert Reider (619)694-8852

SAN JOAQUIN VALLEY UNIFIED APCD (all of Fresno, Kings, Madera, Merced, San Joaquin, Stanislaus, Tulare, and W portion of Kern counties)
1999 Tuolumne, Ste. 200
Fresno, CA 93721-1638
(Central - Fresno)
Dave Mitchell (209)497-1075
(South - Bakersfield)
Joe O'Bannon (805)862-5200
(North - Modesto)
Tracy Bettencourt (209)545-7000

CALIFORNIA AIR POLLUTION CONTROL DISTRICT CONTACTS
(continued)

SAN LUIS OBISPO COUNTY APCD (all of San Luis Obispo County)
3433 Roberto Court
San Luis Obispo, CA 93401-7126
Randy LaVack/Larry Allen (805)781-5912

SANTA BARBARA COUNTY APCD (all of Santa Barbara County)
26 Castilian Dr. Suite B-23
Goleta, CA 93117-3027
Vijaya Jammalamadaka (805)961-8893

SHASTA COUNTY AQMD (all of Shasta County)
1855 Placer Street, Ste. 101
Redding, CA 96001-1759 (530)225-5674

SISKIYOU COUNTY APCD (all of Siskiyou County)
525 So. Foothill Dr.
Yreka, CA 96097-3036 (530)841-4029

SOUTH COAST AQMD (Los Angeles County [except for area within the Antelope Valley APCD], Orange County, W portion of San Bernardino and W portion of Riverside counties)
21865 E. Copley Dr.
Diamond Bar, CA 91765-4182
Steve Smith/Darren Stroud (909)396-3054 or (909)396-2526

TEHAMA COUNTY APCD (all of Tehama County)
P.O. Box 38 (1750 Walnut St.)
Red Bluff, CA 96080-0038 (530)527-3717

TUOLUMNE COUNTY APCD (all of Tuolumne County)
22365 Airport
Columbia, CA 95310 (209) 533-5693

VENTURA COUNTY APCD (all of Ventura County)
669 County Square Dr., 2nd Fl.
Ventura, CA 93003-5417
Chuck Thomas (805) 645-1427

YOLO-SOLANO AQMD (all of Yolo and E portion of Solano counties)
1947 Galileo Ct., Ste. 103
Davis, CA 95616-4882
Carl Vandagriff (530) 757-3668

Appendix G. State Of California Counties And Air Basins

A map is available on the internet at:
www.arb.ca.gov/emisinv/maps/statemap/dismap.htm

and also at:
www.arb.ca.gov/capcoa/roster.htm

Appendix H. Average Summer and Winter Temperatures

Appendix H. Average Summer And Winter Temperatures

AVERAGE SUMMER OZONE TEMPERATURES						
AIR BASIN	**COUNTY**	6 a.m. to 9 Am.	9 a.m. to noon	noon to 3 p.m.	3 p.m. to 6 p.m.	Average Temperature
Great Basin	Alpine	57	70	72	68	67
	Inyo	72	90	97	93	88
	Mono	63	79	79	79	75
Lake County	Lake	71	87	94	91	86
Lake Tahoe	El Dorado*	55	74	78	75	71
	Placer*	55	74	78	75	71
Mountain Counties	Amador	80	87	90	89	87
	Calaveras	80	87	90	89	87
	El Dorado*	72	82	85	85	81
	Mariposa	80	87	90	89	87
	Nevada	71	80	84	83	80
	Placer*	80	85	88	88	85
	Plumas	71	80	84	83	80
	Sierra	71	80	84	83	80
	Tuolunme	80	87	90	89	87
North Coast	Del Norte	51	55	57	57	55
	Humbolt	51	55	57	57	55
	Mendocino	51	55	57	57	55
	Sonoma*	51	55	57	57	55
	Trinity	54	79	87	87	77
North Central Coast	Monterey	56	70	78	73	69
	San Benito	57	72	79	74	71
	Santa Cruz	52	70	83	78	71
North East Plateau	Lassen	60	74	82	83	75
	Modoc	47	70	80	80	69
	Siskiyou	60	74	82	83	75
South Coast	Los Angeles*	74	85	89	83	83
	Orange	70	80	83	80	78
	Riverside*	78	92	98	93	90
	San Bernadino*	76	92	98	93	90
South Central Coast	San Luis Obispo	64	80	85	79	77
	Santa Barbara	66	72	77	75	73
	Ventura	67	77	78	73	74

* Parts of some counties are located in more than one air basin. Use the county and air basin in which the project is located. Source: Calif. ARB

Appendix H. Average Summer And Winter Temperatures

AVERAGE SUMMER OZONE TEMPERATURES						
AIR BASIN	**COUNTY**	6 a.m. to 9 a.m.	9 a.m. to noon	noon to 3 p.m.	3 p.m. to 6 p.m.	Average Temperature
San Diego	San Diego	70	88	91	85	84
South East Desert	Imperial	90	99	105	103	99
	Kern*	84	96	101	99	95
	Los Angeles*	79	91	96	91	89
	Riverside*	86	97	101	99	96
	San Bernadino*	82	94	101	101	95
San Francisco	Alameda	64	74	82	80	75
	Contra Costa	66	82	92	95	84
	Marin	57	76	89	92	79
	Napa	66	82	93	91	83
	San Francisco	67	83	87	77	79
	San Mateo	62	73	83	80	75
	Santa Clara	66	80	90	89	81
	Solano*	67	83	94	96	85
	Sonoma*	59	81	94	92	82
San Joaquin Valley	Fresno	73	88	98	102	90
	Kern*	78	89	97	100	91
	Kings	73	88	96	100	89
	Madera	71	86	96	99	88
	Merced	70	84	94	96	86
	San Joaquin	66	77	91	93	82
	Stanislaus	67	73	91	94	81
	Tulare	73	87	95	97	88
Sacramento Valley	Butte	75	87	97	99	90
	Colusa	71	87	97	99	89
	Glenn	76	91	99	100	92
	Placer*	80	85	88	88	85
	Sacramento	69	84	97	100	88
	Shasta	74	93	103	105	94
	Solano*	67	83	94	96	85
	Sutter	77	92	99	100	92
	Tehama	75	92	101	103	93
	Yolo	66	82	95	97	85
	Yuba	77	92	99	100	92

* Parts of some counties are located in more than one air basin. Use the county and air basin in which the project is located. Source: Calif. ARB

Appendix H. Average Summer And Winter Temperatures

AVERAGE WINTER CARBON MONOXIDE TEMPERATURES						
AIR BASIN	COUNTY	6 a.m. to 9 a.m.	9 a.m. to noon	noon to 3 p.m.	3 p.m. to 6 p.m.	Average Temperature
Great Basin	Alpine	18	26	34	28	27
	Inyo	19	46	48	28	35
	Mono	18	26	34	28	27
Lake County	Lake	39	48	60	59	52
Lake Tahoe	El Dorado*	16	32	40	33	30
	Placer*	39	52	48	46	46
Mountain Counties	Amador	23	39	44	32	35
	Calaveras	23	39	44	32	35
	El Dorado*	16	32	40	33	30
	Mariposa	37	43	41	38	40
	Nevada	35	45	57	52	47
	Placer*	39	52	48	46	46
	Plumas	36	46	47	43	43
	Sierra	35	45	57	52	47
	Tuolunme	23	39	44	32	35
North Coast	Del Norte	39	48	60	59	52
	Humbolt	39	48	60	59	52
	Mendocino	39	48	60	59	52
	Sonoma*	39	48	60	59	52
	Trinity	39	48	60	59	52
North Central Coast	Monterey	41	51	60	58	53
	San Benito	50	59	65	60	59
	Santa Cruz	47	58	66	65	59
North East Plateau	Lassen	19	30	47	44	35
	Modoc	19	30	47	44	35
	Siskiyou	28	34	41	40	36
South Coast	Los Angeles*	52	68	72	64	64
	Orange	53	67	71	66	64
	Riverside*	56	72	75	68	68
	San Bernadino*	53	72	79	73	69
South Central Coast	San Luis Obispo	39	56	70	66	58
	Santa Barbara	51	64	70	64	62
	Ventura	55	64	68	64	63

* Parts of some counties are located in more than one air basin. Use the county and air basin in which the project is located. Source: Calif. ARB

Appendix H. Average Summer And Winter Temperatures

AVERAGE WINTER CARBON MONOXIDE TEMPERATURES						
AIR BASIN	**COUNTY**	6 a.m. to 9 a.m.	9 a.m. to noon	noon to 3 p.m.	3 p.m. to 6 p.m.	Average Temperature
San Diego	San Diego	48	68	76	69	**65**
South East Desert	Imperial	52	72	81	75	**70**
	Kern*	41	57	64	59	**55**
	Los Angeles*	35	52	63	60	**53**
	Riverside*	50	64	70	66	**63**
	San Bernadino*	48	61	71	68	**62**
San Francisco	Alameda	50	57	62	60	**57**
	Contra Costa	40	49	58	57	**51**
	Marin	42	58	66	62	**57**
	Napa	40	50	59	58	**52**
	San Francisco	47	57	61	55	**55**
	San Mateo	47	57	61	55	**55**
	Santa Clara	47	60	68	64	**60**
	Solano*	40	50	59	58	**52**
	Sonoma*	42	58	66	62	**57**
San Joaquin Valley	Fresno	38	51	64	67	**55**
	Kern*	34	45	57	57	**48**
	Kings	37	48	62	61	**52**
	Madera	43	53	56	50	**51**
	Merced	42	52	63	64	**55**
	San Joaquin	39	52	64	61	**54**
	Stanislaus	42	57	67	62	**57**
	Tulare	38	54	64	60	**54**
Sacramento Valley	Butte	39	51	62	62	**54**
	Colusa	37	52	64	61	**54**
	Glenn	39	55	67	63	**56**
	Placer*	39	52	61	63	**54**
	Sacramento	39	52	61	63	**54**
	Shasta	36	45	53	52	**47**
	Solano*	36	47	57	57	**49**
	Sutter	33	37	48	55	**43**
	Tehama	42	57	66	61	**57**
	Yolo	36	47	57	57	**49**
	Yuba	39	51	62	62	**54**

* Parts of some counties are located in more than one air basin. Use the county and air basin in which the project is located. Source: Calif. ARB